SCIENCE

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*MEDICAL EDUCATION IN THE UNITED STATES.**

ONE of the chief objects of the organization of the American Medical Association was the elevation of the standard of medical education in the United States. In the president's address, the Father of the Association, Dr. N. S. Davis, stated that 'the purpose of the organization was the improvement of our system of medical education and the direct advancement of medical science and practice.'† That medical education in that day was defective, as recognized by the founders of the Association, is shown by the report of the Committee on Medical Education in the year 1850. The committee said, in part, as follows: "Medical education is defective because there are too many medical schools; the teachers are too few. There are too many students. The quantity of medicine taught is too limited; the quality too superficial, and the mode of bestowal of the honors of medicine too profuse and too unrestricted."

* President's address, delivered at the fifty-fourth annual session of the American Medical Association, at New Orleans, May 5-8, 1903.

† Transactions A. M. A., Vol. XVI., 1865.

For many years the association showed its interest in and attempted to influence the elevation of the standard of medical education through a committee on medical education. The 'Transactions' of the association of the earlier years show many reports of this committee, which display much thought and effort on the part of the association to improve the status of medical education at that period of time. James R. Wood, as chairman of the committee, in the year 1858, recommended that the various medical colleges of America be requested to send delegates to a convention of medical colleges, to consider the matter of medical education. This movement finally resulted in the formation of the Association of American Medical Colleges, which thereafter represented, to a degree at least, the American Medical Association in its efforts to improve medical education. Later, the Southern Medical College Association was formed. Together these associations represent about 80 per cent. of the regular medical schools of the country, and these colleges have, in a general way at least, fulfilled the minimum requirements prescribed by the rules of the associations in regard to the preliminary education of students, the length of the college course, and the character of the curriculum.

About twenty-five years ago the Illinois State Board of Health, through the splendid efforts of Dr. J. H. Rauch, its secretary, made a report on the number and character of the medical schools of the country. This board adopted a minimum of requirements of medical schools as a necessary step toward the recognition of their diplomas by the State Board of Health of Illinois. This minimum requirement of the State Board of Health was gradually increased from time, with the result that many of the medical schools were obliged to raise the standard of medical education to enable their graduates to obtain licenses to practice in Illinois. Other states followed Illinois in requirements for better methods of medical education, with the result that the standard of education in the country was very much improved.

MEDICAL SCHOOLS OF THE COUNTRY.

In the earlier days of our country, the need of physicians was met by the organization of medical schools which were, as a rule, proprietary in character. These schools attempted the education of physicians on the then existing conditions of medicine by teaching in a didactic way the principles and theories of medicine and surgery. The branches usually taught at that time consisted of anatomy, physiology, chemistry, materia medica, obstetrics, the practice of medicine and of surgery. But little opportunity was offered in the great majority of the schools for extensive, practical teaching in anatomy or chemistry, and but a moderate amount of clinical work in the so-called practical chairs. The course of medicine in the college consisted of two annual sessions of four or five months. The course was not graded. The student attended all the lectures and clinics taught during his first year, and the second year was a repetition of the first. This class of schools was rapidly increased in the course of time. The chief reasons therefor were the fact that it was recognized that a connection with a medical school was profitable, directly and indirectly. The prestige which the teacher enjoyed among the graduates and the laity brought him a remunerative consultation and private practice. In most of the states it was easy to incorporate and obtain a charter for a medical college. It cost comparatively little to conduct and maintain the institution. Lecture rooms were obtained at trifling cost. The dissecting room was not worthy of the name of a laboratory, and the chief

expense in maintaining it was the cost of dissecting material, which was usually deficient in quantity and poor in quality. Medical schools were organized all over the country, without reference to the needs of the people. Medical education was prostituted. To obtain a sufficient number of students many institutions showed a most degraded disregard of the moral and mental qualifications of the matriculates. The income of the school was wholly derived from the tuition of students, and no applicant was turned away who had the cash with which to pay his way. To add to the facility of obtaining a medical college course, there were organized in some cities evening schools, the hours of college attendance occurring from 7 to 9 or 10 o'clock at night. These sundown institutions enabled the clerk, the street-car conductor, the janitor and others employed during the day to obtain a medical degree.

In spite of the general tendency to increase the facility by which a medical degree could be obtained, there was a force at work to improve the methods of medical education. A few older medical colleges and an occasional new one set the standard high in relation to the existing status of medicine. There were earnest, forceful medical men in some of the schools who fought for a higher standard for matriculation and graduation.

The medical college associations exerted a splendid moral influence for good, and the state boards in all the more advanced states have, by mandatory legislation, compelled the colleges to raise the requirements in reference to the preliminary education, the length of the annual session, the time of medical college study, the character of the curriculum, etc. As a result, the status of medical college education has been very much improved in the last twenty, and chiefly in the last ten years. But, improved as it is, there are evils which menace us, the chief of which still are too many medical schools, too many students, and inadequate facilities for the proper teaching of medicine.

The improvement in medical college requirements has increased the cost of the maintenance of the medical college to a degree that it is no longer a profitable financial venture. There can be no dividends. Indeed, the proprietors of the private institution must often make up a deficiency in the annual budget. In spite of this fact, medical colleges have continued to increase steadily.

In 1877 there were sixty-five medical schools in the United States. In 1882 this number had increased to 89, and 1901–2 to 156. The enrollment of students and the number of graduates have also increased, in spite of the fact that the requirements for matriculation and graduation have been increased. In 1882 there were* 14,934 matriculates, and this number was increased in 1901 to 26,417, and in 1902 to 27,501, an increase of about 100 per cent. in twenty years.

The number of graduates in 1882 was 4,115; in 1901, 5,444; in 1902, 5,002, an increase of about 25 per cent. in twenty years. If, in 1850, there were too many medical schools and too many students, what can we say of the condition to-day?

It has been estimated that there is an average of one physician to 600 of the population of the United States at the present time. The natural increase in the population of the country, and the deaths in the ranks of the profession, make room each year for about 3,000 physicians, based on the proportion of one physician to 600 of the population. With 5,000 or more graduates each year, a surplus of 2,000 physicians is thrown on the profession,

* *The Journal A. M. A.*, Vol. XXXIX., No. 10, p. 574.

overcrowding it, and steadily reducing the opportunities of those already in the profession to acquire a livelihood. The evil of an overcrowded profession is a sufficient cause of complaint, but the cause thereof is the important point for us to consider and, if possible, remove. To correct the evil, the ease and facility with which a medical degree may be secured in this country must be diminished. As before stated, there are now 156 medical schools in this country. Of these, 30 are sectarian, and 136 are so-called regular schools. Fifty-eight are medical departments of universities, of which twenty-four are state institutions. The relation of the medical school to the university in most instances is a nominal one only. In but few of them is the control of the faculty, or the finances of the medical department, vested in the university proper. In a very few of them the sciences fundamental to medicine are taught in the university. In the majority of these schools these departments are duplicated in the medical department, and are taught by members of the medical faculty. In most instances, too, the teachers of the fundamental branches are physicians who devote but a part of their time to teaching. They teach without a salary, or for a nominal one only. Their remuneration is obtained by private practice, to which they must devote their best energies, to the detriment of their value as teachers. The clinical department of these schools is, in most instances, wholly inadequate. The majority of such schools depend on the general hospitals situated near them for the privilege of the use of clinical material. Necessarily, these clinical advantages have great limitations, inasmuch as they can not be fully controlled for the purpose of proper bed-side teaching, or for scientific investigation. Some of the medical schools which are connected with state universities are situated in small cities where it is impossible to command an adequate amount or variety of clinical material. The connection with a university, which many of the schools enjoy, is, therefore, almost valueless in a pedagogic sense. The majority do not differ materially from the private or proprietary schools in their value as teaching institutions. Ninety-eight of the medical schools in the country are private corporations, organized, maintained and, as a rule, owned by the faculty. If, in earlier years, these institutions were sources of direct financial profit to the owners, they have ceased to be so now—at least most of them. The evolution of medicine has made it necessary to extend the laboratory method of teaching. As these schools attempt to teach the whole curriculum, the erection, equipment and maintenance of the necessary laboratories have so increased the cost of conducting the schools that they are usually no longer self-supporting. The temptation is in such schools to conduct them on a plane which shall just comply with the minimum requirements of the various state bodies, which regulate medical practice in the several states. They are maintained ostensibly to teach medicine, but in reality for the prestige which a professorship affords the teacher in his private and consultation practice. Proprietary schools depend on general hospitals and dispensaries for clinical material. What was said of the status of clinical teaching of the medical departments of the universities is true also of the proprietary college. These schools can not hope to improve their present standards. The majority attempt to maintain laboratories and other expensive means of teaching which a modern medical education demands. But in how many are the laboratories worthy of the name? What kind and variety of instruments and apparatus do

they afford? Are their teachers of the sciences of the fundamentals of medicine capable? They can not hope for better conditions, because the time when a student's tuition will pay the school for his instruction, if he is properly taught, will never return. Medical education of the future must be based on the status of medical science. That basis is recognized now, but is attempted in the great majority of our medical institutions in a very superficial way.

SCIENTIFIC MEDICINE.

The great and important discoveries of Pasteur and the practical methods devised by Koch in bacteriology marked a new era in medicine. Before the facts made clear by these discoveries, the hypotheses and theories of other days have disappeared. Our knowledge of man and the lower animals and of the diseases and evils which afflict them has been revolutionized within the last twenty years. The advance in medical knowledge has been greater in that period than in all preceding time. Medicine now embraces many more subjects, chiefly fundamental ones, than were known twenty years ago. Formerly a very superficial knowledge of a few isolated facts in general chemistry and human physiology and a memorized knowledge of human anatomy and of materia medica enabled the student to learn the practice of the art of medicine and surgery. Now, the problems which confront the clinician and investigator in medicine and surgery compel him to have a good and working knowledge of general, physical and physiologic chemistry, of general biology, bacteriology, pathology, physiology, embryology, pharmacology, histology and anatomy. The physician who has not a practical knowledge of these fundamental subjects can not clearly understand the methods of others engaged in scientific investigation, nor can he rationally utilize the discoveries of others in his work. Medicine to-day is applied science. If we utilize the knowledge of to-day in an attempt to cure and prevent disease, it must also be an experimental science. No one can practically apply or rationally experiment with what he does not know. The fundamental studies of medicine must, therefore, be acquired by all who desire to successfully apply them as sciences. The successful experimental application of these sciences has given us within ten years a knowledge of the method by which the invading bacteria affect the host, and has likewise developed a principle of wide application as a preventive and cure of certain diseases by the use of antitoxic sera. It has confirmed the principle of preventive inoculation, accidentally discovered by Jenner, and has enabled us to apply the principle in other diseases than smallpox. It has enabled us to know the methods of transmission of certain infectious diseases, and to know how to stamp out scourges like yellow fever, the plague and malaria.

Through the evolution of Listerism, it has enabled the surgeon to invade every region of the animal body, and to save scores of lives formerly doomed to death. The freedom with which the surgeon may now operate has not only saved lives, but, indirectly, the knowledge of disease processes so studied during life has taught us many new facts in symptomatology, and has cleared away many fallacies concerning pathologic processes. It has given us many new methods of clinical study, and furnished data from the blood, the spinal fluid, the exudates, the sputa, the sweat, the feces, and urine, which enable us to recognize disease much more readily than before.

Much as has been accomplished by experimental medicine in a comparatively brief period of time, there are vast fields to which the method has not been applied.

With most of us, our present methods of clinical observation enable us to do little more than name the disease. In the vast majority of the infectious diseases we are helpless to apply a specific cure. Drugs, with the exception of quinin in malaria, and mercury in syphilis, are valueless as cures. The prevention and cure of most of the infectious diseases is a problem which scientific medicine must solve. What is true of the infectious diseases is also true of the affliction of mankind due to chemical influences within the body. We know but little of diabetes, of the primary blood diseases, or of the various degenerative processes of age and disease. We hopefully look to chemistry to reveal to us the cause of these and other conditions. Experimental medicine must be the means of removing the ignorance which still embraces so many of the maladies which afflict mankind. Not every student, nor every physician, can become an experimenter in applied medicine. Nevertheless, every physician must be so educated that he may intelligently apply the knowledge furnished him by experimental medicine in the cure of such diseases as can be cured. He will no longer juggle with the life of his patient by an attempt to cure with drugs or otherwise, where no help is possible.

METHODS OF MEDICAL EDUCATION.

The phenomenal evolution of medicine has multiplied the subjects of medical study. The character of these sciences requires that they shall be taught by the laboratory method. The laboratory method, too, has been adopted as the chief method of instruction in anatomy, pharmacology and chemistry, formerly almost wholly taught in medical schools by didactic lectures. The laboratory method, while necessary to the proper and practical instruction of the student, involves an expense which is appalling when compared with the methods of teaching formerly practiced in all schools, and still adhered to in many medical schools. The method is expensive, inasmuch as it involves more extensive buildings, much expensive apparatus and an increase of the teaching force. The instruction must be individual or to small groups of laboratory workers, and this involves also an extension of the time of instruction. A physician engaged in private practice can not possess and retain the general and technical knowledge necessary to enable him to teach one of the fundamental sciences properly, nor can he devote an adequate amount of time to it. The teachers of these fundamentals must be investigators in the province of their respective sciences. They must give their whole time to the instruction of students and to original investigation. The thoroughness and accuracy of the training of the special senses, and in experimenting, which a student will receive from such teachers in properly equipped laboratories, will make him keen in intellect and sound in judgment. His desire for knowledge will be stimulated by the atmosphere of his surroundings, and will awaken in him a consciousness that through him and his work the knowledge of the world will be increased and humanity benefited thereby. But teachers of this character must be paid salaries quite as large as the remuneration of professors in the departments of arts, literature and science. The salaries of such professors and of the corps of assistants which the laboratory method implies make the cost of the university or college far beyond the income which could be derived from the tuition of students. I believe it has been estimated that the laboratory method of instruction, now followed by all first-class institutions of learning, costs annually from $400 to $500 per student. But, great as the cost seems, it must

be conceded that the present status of medicine demands the thorough instruction of students in these fundamental studies. It matters not whether his future may be that of a teacher or a practitioner of medicine. In either event, he must apply his knowledge of the fundamental sciences to his work, and the result will depend on the thoroughness of his education.

APPLIED MEDICINE AND SURGERY.

To enable the student to utilize the knowledge of a thorough training in anatomy, physiology, chemistry, pharmacology, physiologic and physical chemistry, embryology, neurology and pathology, he should be afforded facilities of equal rank in clinical medicine and surgery. To supply the student with proper clinical facilities involves several important features. Special hospitals, which would be absolutely under the control of the medical school, would be necessary. The hospital should be constructed with a definite idea of teaching students and of making researches into the nature, causes and treatment of disease, as well as to care for a definite number of patients. Hospitals for general medicine, surgery and obstetrics would be essential. Such hospitals, with laboratories and equipped with instruments, apparatus and library, would cost for their building and maintenance a very large sum of money. With such hospitals it would be necessary to choose the professors of medicine, of surgery and of obstetrics, with competent assistants, of the same type as the teacher of the fundamental sciences. They should give their whole time to the work of teaching and to original research in the hospital. They should be men who have proved their scientific fitness for the important positions by the contributions they have made to medical knowledge. They should rank with and receive the pay given to professors of important departments in arts, philosophy and science. When so paid, they would be free to devote all their energy to teaching, and to experimental medicine—a career which would enable one to be of the greatest possible service to mankind. No life's work could be fuller or of greater self-satisfaction, and surely none would be more honorable. From these teachers and investigators the student would obtain instruction of the same systematic methods of accurate observation and investigation which are employed in the fundamental branches. He would receive thorough, conscientious drill in the fundamental methods of examination of patients, and his knowledge of the fundamental sciences would be constantly applied in this work. The trained clinical teachers would direct the student in thorough, careful observation in the wards and at the operating table, would collect data to be submitted to experimental tests, and would conscientiously carry out the experiments in the laboratories of the hospital.

The brilliant discoveries which have made our knowledge of the cause and means of transmission of many of the infectious diseases have been chiefly due to the introduction of the experimental method of investigation. Teachers and investigators of the type mentioned will have the opportunity to make equally important discoveries in the broad field of the unknown in medicine. They will train students in the methods of research work and constantly increase the number of investigators in the domain of medicine. And there is need for such men. We may give the great practitioners who have taught clinical medicine their due meed of credit for their excellent, painstaking, unselfish efforts as teachers. They have added to the sum total of our clinical data, have utilized the knowledge of the pathologist and the physi-

ologist in diagnosis, and have tested and judged the worth of therapeutic aids in the treatment of disease. But as teachers they have not made students investigators or experimenters. Not one of the recent great discoveries in medicine has been made by such a man. He has used as clinical material hundreds of cases of pneumonia, rheumatic fever, tuberculosis and chronic diseases by the score; his experience has taught him to recognize these diseases, even when the clinical manifestations are obscure, but he is no more successful than when he began to practice in saving the life of the patient with pneumonia, in preventing endocarditis in rheumatism, in curing tuberculosis, or in checking the advance of a chronic hepatitis. It is time, therefore, that the clinical teacher should have the knowledge necessary to carry on experimental investigation, with hospital facilities for the work that the profession may become purged of the shame of helplessness in curing so many of the common diseases of mankind.

The patients who will be received in these hospitals will be fortunate. They will receive the most painstaking examination and study, and the experiments made on animals in the laboratory will benefit the patients directly, inasmuch as more rational therapeutic measures will be applied in cases so investigated. In addition to the clinical teachers, who will devote all their time to teaching and research work in the special hospitals, there will be quite as much need for the clinical teacher, who is in private practice, in the general hospitals. Under his direction the student may himself investigate a hospital or ambulatory case, and undertake the care of the patient. His rich and varied experience in hospital and private practice will enable him to round out the student's college education. He will impart to the student a better idea of medicine as a whole. He will coordinate and arrange the isolated facts of clinical and laboratory investigation, and give them their true and relative value. He will teach the student the art of medicine; he will teach him that human sympathy and encouragement of the sick and dying are a part of his duty as a physician.

It would be most practical to make the clinical work of the third year a clinical drill and experimental course, given in the special hospitals, and assign the students of the fourth year to the general hospitals and to the clinical teachers who are in private practice. All the general hospitals and dispensaries controlled by the medical schools could be utilized in the fourth year for this purpose, and afford the student an abundance of clinical material and the benefit of the experience of many clinical teachers. Many of the assistants in the special hospitals, of the third year course, would doubtless engage ultimately in private practice, and would, because of their scientific attainments, make excellent clinical teachers in the fourth year. A medical school conducted on the high plane advocated must necessarily be under the control of a university. Such a medical school would cost an enormous amount of money, and this can be commanded only by the trustees of a university of the highest order. That the money for the purpose of establishing and maintaining university medical schools with research hospitals and university clinical courses will be forthcoming can not be doubted. The world is awake to the great discoveries recently made in medicine. The wealthy men of this country have had their interest aroused as never before in reference to the possibilities and benefits which medical investigation will give to mankind. They now recognize that they and all posterity will

be benefited by every new fact discovered in medicine, and that physicians thoroughly and scientifically trained are necessary to conserve the health of the people.

Three years ago Professor W. W. Keen, in his address as president, deplored the fact that medical schools received relatively little aid in the form of endowments as compared with universities and colleges of philosophy, art and theology. Since that time several millions of dollars have been given for medical education and scientific research. The signs of the times point to a brighter future of medicine in America.

EDUCATION PRELIMINARY TO MEDICAL STUDY.

The subject of the educational requirements for matriculation in medical schools has been discussed at many meetings of this Association in its earlier years, and later by the college associations, by the American Academy of Medicine and by the various state boards of health.

The requirements were at first lamentably low, and the efforts of the Committee on Education of the American Medical Association and of the college associations had but little effect, because they possessed no legal power to control the schools.

The influence of the various boards of health of several states, notably Illinois, was more marked, inasmuch as these state boards possessed a mandatory power. The colleges were forced to adopt the minimum educational requirements of the state boards of health if their diplomas were to be recognized by the respective state boards.

These moral and legal influences to improve the preliminary requirements were almost nullified by the practice of a majority of the medical schools in admitting students whose educational status was examined into and judged by a committee of the college faculty.

This practice is still followed by a majority of the medical schools, and results in the admission of many students who are unable to fulfil the prescribed requirements. As a subterfuge, students are often matriculated conditioned in one or even several subjects. Then the student and the faculty committee forget all about the subject, and the student completes his course, goes into practice, and dies with the conditions still undischarged.

The present requirements of the college associations and of the various state medical examining boards and state boards of health amount, on the average, to a high-school education. The curricula and length of course of the high schools of the different states, and even in the same state, differ very substantially. However, if the medical schools now in existence would honestly require as a minimum education the diploma of a high school, without regard to the rank, it would be a marked advance over the present requirements as practiced by most schools.

We must admit, too, that there are medical schools of such low educational grade that they have no right to demand of their matriculates as much even as a common school education. This fact that low-grade medical colleges exist is one of the most satisfactory explanations of the difficulty encountered in elevating the standing of preliminary requirements.

To get at the root of the matter the medical college must be brought up to the proper educational standard, and then, and then only, can be made a proper preliminary educational requirement.

UNIVERSITY MEDICAL COLLEGES.

The present status of medical science requires and demands a university medical college course. By university medical college is meant a medical school which is directly connected with and a part of a university; the university fixing the requirements and controlling the admission of stu-

dents to the medical department. The method of teaching both the fundamental and the clinical branches is on the principles outlined above. To properly prepare for such a course the student should have, as a minimum preparation, at least two years of study in a good college or university. The requirements to enter a good college or university would insure a sufficient knowledge of the ordinary school branches and also Latin or Greek. During the two years' course in college his time would be well spent in the study of English, French, German, mathematics, history, philosophy, physics, chemistry, general and organic, and qualitative analysis, comparative anatomy and general biology. The amount of time to be devoted to each of these subjects would be the same as that of students of general science, as arranged in all college curricula, with the exception of a much more thorough course in chemistry, biology, physics and comparative anatomy.

So prepared, the medical matriculate would be able to grasp all the intricacies of the subjects of the fundamental branches of medicine. With the addition of the full medical college course, as outlined above, his education would be equal in culture to that of the graduate in arts and philosophy. At the same time, it would be practical and especially fit him for his work as a scientific investigator or practitioner, or for both.

With the medical profession so educated a physician would be, in truth, a member of a learned profession. From an educational point of view he would rank as an equal with the scholar in philosophy, law and theology. As a man he would be recognized as the greatest benefactor of mankind.

With the establishment of university medical schools the first two years of work in the medical school will consist of courses in pure science. Then, doubtless, all universities will adopt the plan which two or three universities have already put in practice. That is, that the student who completes the first two years of the science course of a university, or at a college of good standing, may enter the sophomore year of the university and take the first two years' work in medicine, as the sophomore and senior years of the bachelor's course, when he would receive the degree of S.B. The student who completes the three years of the arts or philosophy course at a university, during which he should take a large amount of work in physics, chemistry and biology, could then enter the medical college and after two years receive the degree of A.B. or Ph.B. After two years spent in the clinical school he would receive the degree of M.D.

This telescoping of the literary and medical courses affords the advantage of an economy of time, while it does not in any way lessen the value of the result to the student. In the one case the student secures the degrees of S.B. and M.D. after six years of study, and in the other the degrees of A.B., or Ph.B., and the degree of M.D. at the end of seven years' study.

THE OUTLOOK OF MEDICAL EDUCATION IN THE UNITED STATES.

Medical education must advance to its proper level if it complies with the present status of the medical sciences and the demands which continued evolution in medicine promises.

What does this imply? It means that the private—the proprietary—medical school which is conducted for commercial reasons must go. Acknowledge, as we must, the great value which the best of these schools have been to the profession and to the country, all such schools have

lived past the time when they can be of value. The continuation of these institutions henceforth will be harmful. They can not command the money to build, equip and maintain the laboratories and hospitals which a proper and adequate medical education demands. In the past their graduates have furnished the many great and influential medical and surgical clinicians of this country. In former days a graduate poorly prepared has been able, by indefatigable labor and post-graduate work, to place himself in the front rank as a clinical physician and surgeon.

To-day medical science demands primary instruction to fit a man as an investigator and scientific physician. If not properly educated he can not grasp the great problems which medicine presents to-day as he did the more simple clinical facts which comprised the art of medicine and surgery a few years ago. In the future medicine must be taught in the large universities of the country and in the state universities which are situated in or near large cities, where an abundance of clinical material may be commanded.

The state university and the college which desires to teach medicine, and is so situated that it can not command clinical material, should confine itself to teaching the sciences fundamental to medicine. These should be taught as pure sciences, and should be included in the course for the degree of S.B. A college or state university ambitious to teach the medical sciences can do so without great cost. To attempt to teach applied medicine without proper and adequate hospitals, and with an insufficient number of patients, would be irrational, nor can they command the necessary funds with which to do it. From such colleges and state universities the students could go to the larger institutions which are able to furnish the proper facilities for teaching applied medicine and surgery.

The general hospitals of many of the cities, now used by proprietary schools, could be utilized as clinical schools for both undergraduate and post-graduate teaching, conducted by the clinical teachers in the existing proprietary schools. Indeed, these hospitals could be utilized as university extension clinical courses. Necessarily, they would have to be under the control and direction of a university medical school.

How many schools may be necessary to educate the number of doctors of medicine required annually in the United States? The question one can not answer, but it is safe to say that 2,500 graduates annually will fully supply the demand. This would imply about 10,000 to 12,000 matriculates. A minimum number of twenty-five and a maximum number of thirty-five medical schools should offer sufficient facilities to educate 10,000 students. The various state universities and the colleges which offer adequate science courses would educate a great number of students in the fundamental branches, or in the first two years of the medical course.

MEDICAL RECIPROCITY BETWEEN THE STATES OF THE UNION.

The low requirements of some medical colleges, and the want of uniformity in the requirements for a license to practice in the different states, has resulted in a condition which entails much hardship on a physician who desires to remove from one and to engage in practice in another state. The rules of most state boards of medical examination and of health are so stringent that a physician or surgeon of years of experience and of acknowledged skill and education, and the specialist who may be renowned in his field of work, are obliged, like the recent graduate, to take an exam-

ination in all of the branches of medicine and surgery in order to secure a license to practice in the state of his adoption.

To correct this evil it has been suggested by a member of the American Medical Association, and concurred in by others, that a national board of medical examiners be organized; that the board hold examinations at different seasons of the year in the various large cities, and that the diploma so obtained shall be recognized as a license to practice in any one or all of the states and territories. The measure suggested seems to be practical and feasible.

In addition to this plan, it remains to be said that the degree granted by the future university medical school will be undoubtedly recognized as an evidence of fitness to practice in any state in the Union. When we shall have a less number of schools and annual graduates the various states may safely and rationally become more liberal and discriminating in the conduct of their office.

THE INFLUENCE OF THE AMERICAN MEDICAL ASSOCIATION.

The American Medical Association should maintain its interest in the elevation of the standard of medical education, one of the chief reasons of its organization. Its influence in former years was principally moral. This was of considerable value, for the reason chiefly of the high ideals of the founders and first members of the association, who advocated and fought for a higher standard of medical education. In the future its influence should be many fold that of the past, for with the reorganization of the profession, the better methods of conducting its affairs, the increased and probably very large membership, and its great medical journal, it should wield a great influence for good.

As the direct agent by which the American Medical Association may exert its influence in the elevation and control of medical education, the Committee on Medical Colleges and Medical Education should be made permanent and should be given adequate power and sufficient annual appropriation to make its work effective.

This association should, therefore, stand for, and should use its whole power to improve, medical education in this country. It is said that we never exceed our ideals in practice, and that if we lower our ideals our conduct sinks to a lower level.

The American Medical Association should take as its ideal and standard of medical education the university medical college, with all the name implies in regard to the fundamental medical sciences, and to the clinical branches. It should use its influence to drive out of existence those proprietary medical schools which are conducted solely as money-making institutions. These measures can not be accomplished at once; but medical science demands it, the profession demand it, the people demand it, and look to the American Medical Association as the chief influence which shall accomplish this end.

Frank Billings.

Chicago.

*THE RARE EARTH CRUSADE; WHAT IT PORTENDS, SCIENTIFICALLY AND TECHNICALLY.**

In the movement of economic and social forces the closed century knew four periods of intensified activity. In 1775, a memorable date in American history, Watt began the manufacture of the steam-engine. During the adolescence of our own country revolutions were wrought in the commercial world by the invention of the locomotive by Trevethick (1801), the loom by Jacquard (1801), and Fulton steamed upon the Seine. By the beginning of the nineteenth century the inventions of Watt and

* A lecture delivered before the Chemists' Club, New York, by request, April 8.

Boulton, Arkwright and Hargreaves, were completed and something like the modern factory system was begun. From industrial history we gather that 'England increased her wealth tenfold and gained a hundred years' start in front of the nations of Europe.'

While vigorous protests, some even violent, as the riots at Lyons and the destruction of Hargreaves' home in England, were made against this rampant spirit of industrialism, there was witnessed a literary renaissance in Great Britain second only to 'the spacious times of great Elizabeth.' That age nourished Keats, Shelley, Byron, Scott, Coleridge, Wordsworth, Burns and Burke. C. Alphonso Smith in his exquisite essay on 'Literature and Industrialism' says: 'In a love of nature that made all seasons seem as spring, in devotion to democratic ideals, in variety of range and intensity of feeling, this period takes precedence of Elizabeth's reign.' It was of this age that Wordsworth said:

> "Joy it was in that dawn to be alive,
> But to be young was very heaven."

Granting Tolstoi's definition of science as a 'mere gratification of human curiosity,' we realize that 'science is history making,' for it was in this period that Volta and Galvani (1801) gave us a source of power and a means of applying it. At the close of the time Dalton had announced the atomic theory and Davy had obtained the alkali and alkaline earth metals.

In the second period, about 1840, there accumulated the potentialities that shaped what is termed the Victorian Era. Quoting Smith again, "In those years railroads first began to intersect the land, telegraph lines were first stretched and the ocean was crossed for the first time by steam-propelled vessels. All these mechanical triumphs tended to annihilate time and space. The products of manufacture could now be sent with dispatch to the most distant quarters. Nations came closer together. The two hemispheres became, and have continued, one vast arena of industrial and scientific interchange. * * * "

The literary record of this period contains the names of Tennyson, Goethe and the Brownings as poets; Dickens, Thackeray and George Eliot in fiction; Ruskin and Carlyle in miscellaneous literature. In America, during this Mexican War period, we had Longfellow, Lowell, Whittier, Hawthorne, Emerson and Holmes, 'the six names that have given the New England states their incontestable supremacy in American literature.'

The part played by the south in literature during these periods was not prominent. The preeminence of that part of our country in forensic art and oratory need not be considered, nor need we discuss the social conditions, and honest difference of opinion as to the proper interpretation of the true relationship of the government as a whole and the integral states which constituted it, other than to say that the south, conquered, as was necessary, came out of the Civil War with new economic ideas, with a renewed and 'ever-increasing development of her natural resources, with a more flexible industrial system, a more rational attitude toward labor, and more enlightened methods of education and with it there came a literary and scientific inspiration impossible before.' In the year 1870, our third period, which statisticians take as the birth year of the new industrial movement in the south, flashed out new literary stars such as Sidney Lanier, Charles Egbert Craddock and George W. Cable. That year can not be named in the presence of scientific men without our thoughts reverting at once to the names of Mendeleeff and Meyer.

The last period is but as yesterday, even to-day.

"All the world's a stage
And all the men and women merely players."

It has been called the age of trusts and mistrusts. In it we must realize that science and its applications must face vested interests; these must be overwhelmed or its universal monopolistic rights be pigeonholed by purchase. Let us realize, however, in this time, as Boyle has said, that 'men often suffer as much cold and wet and dive as deep to fetch up sponges as to fetch up pearls.'

In 1788 Geyer discovered the new mineral, gadolinite, and in 1794, the Finnish chemist, Gadolin, separated a new earth, or oxide, in a black mineral found at Ytterby near Stockholm, and called it yttria. In 1803 another Scandinavian mineral, then known as 'the heavy stone of Bastnäs,' or cerite, was discovered by Berzelius and Hisinger and Klaproth in Germany.

In 1839 Mosander discovered lanthanum in this earth. Three years later he resolved it into two elements, one giving a white oxide and the other a pink, namely true lanthanum and didymium. Scheerer noted that yttria, which is white when heated in a closed vessel, becomes yellow when heated exposed to the air. He, in consequence, assumed that it was a complex substance and the year following (1843) Mosander proved that it could be resolved into three earths, one being colorless (true yttria), the second rose-colored (terbia), and the third (erbia) giving colored salts, but a deep yellow peroxide.

H. Rose in 1839 analyzed samarskite and showed it to be a columbo-tantalate of iron and calcium on the one hand and yttrium and cerium mainly on the other. Satisfactory analyses of this mineral, however, were not had for almost a half-century (Swallow, Allen and Smith), when its comparatively abundant occurrence was noted in North Carolina.

Shortly after the discovery of the spectroscope, Gladstone in 1859 observed the surprising fact that certain substances gave absorption spectra, especially didymium. This constituted the first important and is now, perhaps, the most valuable criterion in the investigations of many of the rare earths.

In 1860, Berlin, by means of partial decomposition of the fused nitrates, showed the presence of but two earths where Mosander had reported three, namely, yttria, as given above, and a rose-colored body, which was termed erbia. A reversal of names occurred, for two years later Bahr observed the characteristic absorption spectrum of erbia and Delafontaine found it in Gadolin's yttria and Mosander's yellow peroxide. The typical oxide was assumed to be RO, and it remained for Mendeleeff in the enunciation of the Periodic Law (1870) to give lanthanum the present accepted formula for its oxide, La_2O_3.

These elements were obtained as metals —in the then accepted pure form—and Hillebrand and Norton determined the specific heats, which data have aided subsequent workers materially. These determinations, in the light of knowledge gained within recent years, possess a quondam value, however much care and energy may have been expended in securing them.

In 1878 Delafontaine stated that samarskite contained much terbia. He separated a more soluble formate and announced the new element philippium, which Roscoe, although he noted band λ 450, proved to be a mixture of yttrium and terbium. This band in reality belongs to dysprosium, discovered by Lecoq de Boisbaudran. The same year Delafontaine, having found a mare's nest in samarskite, from which Mosander separated erbium, announced decipium. The absorption bands attributed to this element were λ 416 and λ 478,

which were subsequently appropriated by samarium, reported as a constituent of didymium by de Boisbaudran. Samarium would now have the name of decipium, but for the fact that, in 1881, Delafontaine declared his decipia could be resolved into an oxide without absorption spectrum (true decipia) and one with these lines, or samarium.

J. Lawrence Smith, of Kentucky, in the seventies, announced mosandrum in samarskite. Marignac and Delafontaine independently pointed out that mosandrum was the same as terbium, while later de Boisbaudran demonstrated that it was a mixture of terbia and gadolinia. This 'nebula of elementary matter,' as Petterson puts it in that charming account of the life work of Nilson, appeared to clear up through the work of the English, French and Swiss chemists, Roscoe, de Boisbaudran and Marignac. While 'the beginning of creation is light,' as Carlyle says, the millennium has not yet arrived, for the earths obtained from gadolinite began to break up into a number of new earths.

Cleve (1873) found that the bands of erbium with an atomic weight of 170.5 could be split into those belonging to one element forming a red oxide with the characteristic emission spectrum (by incandescence) of old erbium and another group of two absorption bands in the visible spectrum. These were shown to belong to thulium.

Five years later Marignac found all the absorption bands could be eliminated by successive fractioning, whilst the atomic weight of the remaining oxide increased. This oxide gave colorless salts without absorption bands, and the name ytterbium was assigned to it, with an atomic weight of 172.5. In the erbia fractions Soret found bands which could not be attributed to erbium. This body, designated X, subsequently proved to be Cleve's holmium.

Material giving out, Marignac, with the true scientific spirit, begged other and younger men to take up the work, using larger amounts. This Nilson did and verified Marignac's work. Just before reaching the same point Marignac arrived at, however, Nilson obtained a nitrate of a less basic material of lower atomic weight. One fraction continued to drop, while the other rose until, in the year following (1879), assisted by Thalèn, who examined the products with the spectroscope, Nilson separated probably the two best defined of the rare earths, scandium (44.1) and ytterbium (173). Nilson showed the location of these elements in the Mendeleeff table, the properties of the former having been predicted.

Referring to these elements Mendeleeff says: 'These metals which are rare in nature, resemble each other in many respects, always accompany each other, are with difficulty isolated from each other and *stand together in the periodic system of the elements.'* The last statement is based largely upon analogy, a most valuable method of argument in scientific generalizations without doubt, but, as Davy once said: 'Analogy is the fruitful parent of error.'

In 1880 Marignac attacked samarskite, and by fractioning the double potassium sulphate obtained two oxides in almost pure state, as follows:

$Y\alpha$ giving a white oxide, colorless salts and no absorption bands. Six years later it was called gadolinium and the atomic weight 156 assigned it by Marignac, de Boisbaudran, Cleve and Bettendorff.

$Y\beta$ proved to be samarium of de Boisbaudran, or Delafontaine's original decipium. Marignac, Cleve, Brauner and Bettendorff determined its atomic weight (149–150). While the elementary character of

samarium was questioned by de Boisbaudran and Demarçay, as late as 1893, the latter stated that no real proof of the complexity of samarium had been offered. What an exquisite illustration we have here of Tyndall's dictum, 'Every system must be plastic to the extent that the growth of knowledge demands'; for, but a few years have passed before Demarçay (1901) announces europium, with atomic weight of 151 (approximately), obtained by prolonged fractionation of the double magnesium-samarium nitrate. His observations are reported as proved by reversal, absorption, spark and electric phosphorescent spectra. The element appears to lie between samarium and gadolinium, with several strong lines in the violet and ultraviolet.

In 1883 Crookes brought into consideration phosphorescent spectra obtained in a vacuum tube under the influence of an electric discharge. The year following Lecoq de Boisbaudran obtained another method of securing a phosphorescent spectrum. It is in fact an inverse spectrum, nearly related to that of Crookes, very delicate, being greatly influenced by small amounts of foreign bodies and other conditions. The brilliancy of the bands thus obtained does not depend upon the proportion of the active substance present. A small amount of the body with much inert material gives a bright spectrum, consequently it offered little promise as a method for following the process of fractionation.

Up to this time holmia and thulia had not been freed from the other earths. In 1886 de Boisbaudran showed that holmia was composed of true holmium (162) and dysprosium (?), adverted to, characterized by several bands, the one to which Sir Wm. Crookes called especial attention being λ 451.5. This Englishman later (1889) subjected yttrium salts to a great number of fractionations, several thousand, finding the bands of the original material distributed among the different fractions. From this work he assumed that yttrium could be split into a number of elementary substances, which he termed 'meta-elements,' naming one victorium after the lamented queen. Without doubt Sir William Crookes enunciated in this paper an important principle in inorganic research, namely, what may be termed 'partial cleavage'; that is, the fractioning of a complex mixture of elements may be pushed to an extreme with one compound and the bodies appear elementary. On applying another method, or the same method to another compound of the assumed elementary substance, the cleavage may be brought about in another direction, and so on. The 'genesis of the elements' was the natural theory offered by that master mind. It was strongly combated in the main, however, by de Boisbaudran, who showed that two of the bands obtained, $Z\alpha$ and $Z\beta$, are not at all related to yttria, as the former follows holmium and the latter is identical with terbium. He says, further: 'Perfectly pure yttria gives no phosphorescent spectrum.' Dennis, the American worker on the element in question, appears to agree with the French chemist.

It may be recalled that Delafontaine extracted samarium (his original decipium) from Mosander's didymium. The theoretical work referred to naturally gave rise to the complexity of didymium, which has an absorption spectrum characterized by a number of well-defined bands. In fact, Cleve made the prediction of the presence of another element in lanthanum and didymium in 1878. Carl Auer (von Welsbach), in 1885, by prolonged fractional crystallization of the double ammonium nitrate, obtained from the pink solution green salts of praseodidymium (140) and rose-red

salts of neodidymium (143). The absorption spectra of these two are complementary. The next year Crookes eliminated band after band of the didymium until only λ 443 remained. Krüss and Nilson and Kieserwetter and Krüss prepared didymium from several sources, fractioned the preparations and arrived at a similar conclusion. It is now known, as shown above, that erbium has been resolved into seven other well-characterized elements, viz., besides erbium (166.3), scandium (44.1), yttrium (89), terbium (160), ytterbium (173), thulium (170.7), holmium (162) and dysprosium (?). After the elimination of samarium, didymium shows at least nine distinct absorption bands: λ 728.3, 679.4, 579.2 to 575.4 (which is easily resolved into two), 521.5, 512.2, 482, 469, 445.1 and 444.7 (443) (ultra-violet and infra-red not considered). In short, these two elements neo- and praseodidymium consist of at least nine elements. The full conclusion of Krüss and Nilson may be stated in their own words: 'Nach obigen Auseinandersetzungen hätten wir an Stelle des Erbiums, Holmiums, Thuliums, Didyms, und Samariums die Existenz von mehr als zwanzig Elementen anzunehman.'

While the acceptance of such conclusions without question would be wholly unscientific, we must carefully consider the general idea involved, and the investigations upon which the conclusions were founded and the investigations carried out subsequently to test them. Absorption bands determined under variable conditions are not to be accepted as essential characteristics of new elementary substances, as they have been shown to vary with the salts used. Sorby and Liveing have shown that the character of the solvents and traces of impurities bear importantly upon the intensity of the absorption bands. Lawrence Smith and de Boisbaudran and latterly Dennis and Chamot have called attention to variations in the absorption spectrum of didymium, when nitric acid is present. Becquerel showed there were variations in the spectra of crystalline compounds of the same element. Very recently Muthmann and Stützel have shown that, if a substance be regarded undecomposable, its absorption spectrum varies considerably with dilution and amount of free acid present. Demarçay has urged the necessity of giving the thickness of the medium used, with a statement of its strength.

C. M. Thompson reported that didymium salts from various sources showed no material differences in absorption spectra. Schottländer remarks, however, that the material used contained several oxides, giving absorption bands, so the intensity of certain bands of a particular element may have been increased by the superposition of bands of other elements.

Crookes and Dennis independently made the extremely interesting observation that the heavy orange bands (575–579), which were resolved by Auer, were not altered in their fractions when the remaining lines had undegone some changes, hence the former stated that probably 'didymium will be found to split up in more than one direction, according to the method adopted.' The work of Dennis on the relative intensities of the bands observed, by varying the procedure of fractionation, is in direct accord with the observations of previous investigators as to the compound nature of neo- and praseodidymium.

Von Scheele (1898) carried out a series of investigations looking toward the proof of the elementary character of praseodidymium. Bettendorff, by a spectroscopic examination of the mother liquors obtained by the Welsbach method, confirmed the observations of Krüss and Nilson, especially with regard to the absorp-

tion bands in the blue portion of the spectrum. Schottländer, working with the same object in view, came by no means to the same conclusion. He held it probable that praseodidymium consists of a mixture of two elements, whose oxides burned in air give R_2O_3 and RO_2 (*i. e.*, $R_2O_3 + 2RO_2 = R_4O_7$, the accepted peroxide). His conclusion was founded upon the small per cent. of oxygen present in the peroxide. Forshing confirmed Bettendorff's results spectroscopically and reported Pr α characterized by the yellow bands, and Pr β, which has the three bands in the blue, indigo and violet. Boudouard arrived at the same conclusions. Brauner concluded, in his work on the oxides, 'from the tendency of them both (praseodidymium and neodidymium) to become more highly oxidized than would correspond to the formulæ Pr_2O_4 and Nd_2O_5, that praseodidymium and neodidymium may be further split up.'

Von Scheele maintains that none of the savants has proved Krüss and Nilson's theory that there are four elements present in praseodidymium. By long repetition of the Welsbach process he failed to bring about any variation in the yellow bands, which Bettendorff maintained could be fractioned away, and demonstrated to his own satisfaction the elementary composition of praseodidymium in a paper reciting much careful and patient experimentation. Unfortunately, he ignored the work of Crookes and Dennis, which is dependent upon variation of the finer details of manipulation. In our laboratory, following entirely novel lines of research for this element, we have apparently verified the conclusion of the complexity of the element in question.

The material used was generously presented by Mr. H. S. Miner, the long-time associate and successor of the lamented Shapleigh. It was quite free from neodidymium, but contained a notable amount of lanthanum. The presence of lanthanum facilitates the fractioning of didymium by the Auer method, as pointed out by Dennis. A pure praseodidymium compound is readily had by using the method of Baskerville and Turrentine, namely, fractioning a citric acid solution saturated with the hydroxide, and heating. The citrate obtained was converted into the oxide. This oxide was free from the other elements giving absorption bands in the visible spectrum. So far we have not been able to examine the ultra-violet, but shortly expect the arrival of one of Wood's nitrosodimethylaniline screens, which I am having made for my spectroscope. The instrument is a Steinheil plane grating (made by Brashear) with 14,438 lines to the inch, essentially the same as that described by Dennis in his work with Dales on yttrium, except a size larger. It was purchased by a grant from the Bache Fund of the National Academy. The oxide was proved to be free from elements which give no absorption band, especially lanthanum, by means of photographs of the arc spectrum obtained with a Rowland concave grating (15,000 lines to the inch and twenty-one-foot diameter). The spectrograph work was done by my friend Dr. W. J. Humphreys, of the Department of Physics, University of Virginia, and will be published by us in full at the proper time. The oxide was very carefully treated with hydrochloric acid, bringing about partial solution, whereby a distinct brown oxide was obtained different from the normal black peroxide; further, a separation has been secured by fusion with sodium peroxide.

Other methods of attack have been followed, as, for example, fractional crystallization from a concentrated chloride solu-

tion by means of gaseous hydrogen chloride, fusing with alkaline hydroxides, sodium dioxide, etc. The details will be given in the full papers when published.* Suffice it to say that we have succeeded in obtaining a preparation, which has lost entirely the absorption line λ 443 and another, very small in amount, which shows only that line. The oxide is bright green when heated in the air. The work of Crookes and Dennis is thus verified by entirely novel methods. Drossbach reports the existence of an element in monazite sand with an atomic weight of 100, that is, eka-manganese, but it is discredited by Urbain.

It may be interesting at this point to call the attention of the scientific men of America to the fact that from the locality, Ytterby, where cerite was found, four elements, yttrium, erbium, terbium and ytterbium, have secured a name. From the occurrence of samarskite and monazite (Mitchell and McDowell and other counties in North Carolina and Brazil), which contain most of these rare earths and have furnished so much of the material for the researches, not a single element is named, except the tentative carolinium, which will now receive attention.

The other rare earths to which I wish to direct your indulgent attention in a few words are those which possess radio-activity, a property accidentally rediscovered by Becquerel. It may be remarked that Sir George Stokes fifty years ago addressed the physicists of the British Association on the curious action of certain bodies in emitting light at ordinary temperatures. Little was then known of the phenomenon of fluorescence. There is not time to attempt a discussion of the origin and nature of radio-activity. It appears that our satisfactory Maxwellian theory of the progression of ethereal stresses may yet be harmonized with the older corpuscular view of Descartes and Newton by the recent elegant researches of Becquerel, J. J. Thomson, Rutherford, Giesel and others.

M. and Mme. Curie have been pioneers in utilizing this physical activity, which serves to detect the presence of minute amounts of certain elements contaminating hitherto well-defined bodies. J. J. Thomson, in his recent extremely interesting address at Belfast, brings out a point demanding the chemist's closest attention, namely, that the radio-activity is five thousand times as delicate as the spectroscope, it matters not whether the arc, spark, absorption or phosphorescent spectrum be made use of.

By prolonged fractionation the Curies separated radium from barium salts. Demarçay has prepared the spectrograph showing the characteristic lines of the element, while Madame Curie determined its atomic weight (225). It fits beautifully in Mendeleeff's table. The Curies have also announced polonium, or the active constituent of bismuth. Uranium appears to have been the first to show this property, as noted by Becquerel. Actinium, it seems, is the elusive body found in pitchblende by Curie, and appears to be the same as Crookes' uranium X.

Chroustschoff a dozen years ago announced that thorium contained another element, which he called russium. I have been unable to secure a copy of this paper or even to learn where it appeared. I am informed by Professor Mendeleeff, who

* I have been assisted in the numerous researches barely summarized in this address by Messrs. J. E. Mills, R. O. E. Davis, J. W. Turrentine, James Thorpe, Reston Stevenson, W. O. Heard, Hazel Holland, E. B. Moss, H. H. Bennett, Geo. F. Catlell and F. H. Lemly. The separate papers will shortly be published. Three grants of fifty dollars each have been made by the American Association for the Advancement of Science to aid in the work on the rare earths.

mentions it in his 'Principles of Chemistry,' that Chroustschoff made the announcement before the Russian Chemical Society, but had published no complete investigation. Two years ago, Brauner, working along one line, and I, on another, independently announced the complexity of that element.

It is generally accepted now from the published work that the property of emitting rays which affect the photographic plate is not a specific property of thorium, but characteristic of a constant contaminating constituent of that element. It is well known also that, while some of these radiations or emanations affect the photographic plate, some do not. The electrical method of measurement (quantitative) has been substituted in our work and improved methods of fractionation are being used, whereby we seem to be approaching a non-radio-active thorium and one possessing that property in high degree. Further, similar compounds of thorium fractions similarly treated show almost no difference with the Rowland grating referred to, yet show marked divergence in their radio-active properties. The radio-active work is being done by Mr. G. B. Pegram, of the Department of Physics in Columbia University.

I have not come from 'away down south' to the center of commercial activity of all the Americas to tell you how these rare substances are to be had at low cost, advertise their uses, form a combination and arrange for their sale at a good profit, although one of my neighbors ranks high among Knickerbocker mergers. The fourth period in rare earth activity is coexistent with the extension of the use of some of them for illuminating purposes. The price of thorium nitrate fifteen years ago was over five hundred dollars per pound. Now the market price is about five dollars per pound. Commerce required thorium compounds; they were provided. Commerce demanded thorium compounds at a reasonable price; the demands were met. The prices of certain of the impure rare earths occurring in nature with thorium are high, but their values do not follow well-known economic laws and are purely fictitious. When uses are found, the prices of these by-products will fit the demand.

In this maze of an enticing problem one imagines much and many speculate more. Not unfrequently, especially of late, have we been treated with irenic disquisitions as to the location of these rare elements in the natural system. It appears to be forgotten that Mendeleeff used his table to correct the formulas of the typical oxides of certain elements, as, for example, lanthanum (LaO to La_2O_3). The fact is forgotten that the atomic weights, now ascribed, would be materially different were the type different. The ascribed atomic weights are dependent upon the synthesis or analysis of the sulphates almost without exception. It is forgotten that '-yl' salts, like uranyl, chromyl sulphates are possible for these elements, as recently shown by Blandel for titanium and Matignon for praseodidymium and neodidymium. Furthermore, it is forgotten that the sulphate method is absolutely defective, as Schützenberger pointed out. This has been verified by Wyrouboff, Dennis, Brauner and Pavlicek, and Demarçay, as well as myself. Therefore, all attempts to arrange these elements, some of which are known to be complex, in the periodic table are veriest speculation, which can profit little. It is quite as true also that the table should receive no discredit because it fails to account for them with our present knowledge. According to its author the table reserves twenty-three places for their occupancy.

Two desiderata may be mentioned: (1) Satisfactory tests, preferably colorimetric, which may be quickly applied, as Hillebrand has remarked about titanium. This supplied, perhaps these earths would not be so rare. I have shown the universal occurrence of titanium. (2) Spectral data from more highly purified substances, for much that is now at hand has been obtained from impure earths.

The methods of attack at present are mainly based upon the same phenomena of oxidation, reduction and saturation. The applications are different, however. As typical examples, a few may be cited as follows: Melikow has been using the hypochlorites, virtually the Lawrence Smith method; Muthmann, hydrogen dioxide and acetate solutions; Dennis is using organic acids, as did Metzger for thorium; Jefferson and Allen have applied certain organic bases for analytical purposes, while in our laboratory we have saturated the stable alkalies, fused with sodium peroxide, and reduced with such basic reducing agents as hydrazine and phenylhydrazine, and so forth.

All is not dark, for rifts in the clouds are making. Old Watt said: 'Nature has always a weak side, if we can only find it out.' Looking back and with that century of experiences we can frequently in a measure judge of the future and those things which make toward the true end.

Naturally a sequel is due this paper, and I look forward to presenting it in my vice-presidential address before Section C of the American Association at the St. Louis meeting. Some sequels are better than their predecessors; most of them, however, are not so good.

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SCIENTIFIC BOOKS.

Inorganic Chemistry, with the Elements of Physical and Theoretical Chemistry. By J. I. D. HINDS, Ph.D., Professor of Chemistry in the University of Nashville. New York, John Wiley & Son; London, Chapman & Hall, Limited. 1902. Large 8vo. Pp. viii + 566.

Chemistry by Observation, Experiment and Induction. A Laboratory Manual for Students. By J. I. D. HINDS, Ph.D., Professor of Chemistry in the University of Nashville. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 12mo. viii + 192.

Principles of Inorganic Chemistry. By HARRY C. JONES, Associate Professor of Physical Chemistry in the Johns Hopkins University. New York, The Macmillan Company; London, Macmillan & Co., Ltd. 1903. Large 8vo. Pp. xx + 521.

A Text-Book of Inorganic Chemistry. By Dr. A. F. HOLLEMAN, Professor Ordinarius in the University of Groningen, Netherlands. Rendered into English by HERMAN C. COOPER, Ph.D., Instructor in Syracuse University, with the cooperation of the author. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1902. Large 8vo. Pp. viii + 458.

While the number of smaller and introductory text-books on chemistry which have appeared in this country during the past few years is very large, it is a long time since any new work on inorganic chemistry, which aims to be even tolerably complete, has been published. That three such works should appear within a few months of each other is evidence that a need was felt in this field. This is, of course, due to the revolution, as it might well be called, which has taken place in the fundamental conceptions of inorganic chemistry, and the recognition of the fact that these must be utilized in teaching the subject. This was early seen by Ostwald, and he must be considered the pioneer of the new didactic chemistry.

It is interesting to note how the authors before us have utilized the wealth of ma-

terial placed before them by the physical chemists. One is tempted to use a piscatorial metaphor and to affirm that Hinds has nibbled at the bait, Holleman has taken a good hold on the hook, while Jones has swallowed line, sinker and all.

These books are intended for serious college work, but the question must arise as to whether they would be suited for beginners even in college classes. In some of our colleges, most of those entering have had some smattering of chemistry, and a few have had really thorough grounding in the fundamentals of the science in the secondary schools. Yet in most college classes there are those to whom the subject is new. Just now it seems to be the fad to introduce conceptions of physical chemistry into the elementary text-books, and in one recently published the student meets the theories of electrolytic dissociation and of mass action during the first few weeks of study, while descriptive chemistry is relegated to a score or two of pages at the end of the book. In spite of all that has been said to prove that chemistry will never be a true science until it can be treated on a purely mathematical basis, it still remains the writer's opinion that a knowledge of what is sometimes rather superciliously called descriptive chemistry is fundamental to the thorough acquisition of the science of chemistry. Naturally it is not necessary, in gaining a knowledge of descriptive chemistry, to found it upon theories which are false and must be unlearned at a later period; indeed, too much theory is just what is not called for in studying descriptive chemistry. But a student must have some considerable familiarity with chemical elements and compounds and with chemical reactions before he can at all realize the bearing of chemical theories.

On the other hand, college students are supposed to have a certain maturity and development of mind, which should enable them to handle a subject in a very different manner from students of secondary schools. Theoretically a purely inductive method may be the most scientific, but practically the average college student will weary of following the arguments of a well-developed course of reasoning three or four weeks long, and he will lose his interest. If a partially deductive method be used, if certain of the more prominent lines of the fundamental theories are sketched before him, he sees something of the import of the phenomena he is studying, much to his pleasure and his interest. This appears to be clearly recognized by the authors of the books before us.

In Professor Hinds' 'Inorganic Chemistry' this idea is apparently carried to an extreme, for the whole of the theoretical matter is presented before descriptive chemistry is touched upon, but in this respect the book is not quite so extreme as it seems at first sight, for in the preface the author advises that the book is not intended to be studied consecutively, but lessons are to be taken alternately from the two portions. He suggests a definite order, which, however, any teacher may change to suit his own ideas. In this respect the book takes on somewhat the character of an encyclopedia, where each user may formulate his own logical system for himself. A system, this, which presents some advantages, but also some drawbacks.

This book is divided into four parts: 'Introduction,' 'Physical Chemistry,' 'Theoretical Chemistry' and 'Descriptive Chemistry,' and the third part has two divisions—'Statics' and 'Dynamics.'

The Introduction is brief and contains a short outline of the atomic theory and a description of the various divisions of chemistry.

Part II. is a review of those portions of physics which have a more or less direct bearing on chemistry, with a few pages on crystallography. The chapter on 'Interaction of Solids, Liquids and Gases' is perhaps the most unsatisfactory one in the book. Osmotic pressure is not even alluded to and the treatment of solutions is very inadequate; indeed, the whole chapter might have been written fifty years ago. The chapter on 'Changes of Physical State' is more modern and more satisfactory.

Under the head of 'Statics' we have a discussion of atoms and molecules and their properties, including the classification of atoms, valence, acids, bases and salts, nomen-

clature and some pages on formula writing and structural formulæ. The division on 'Dynamics' includes the chapters 'Chemical Actions,' 'Thermochemistry' and 'Chemical Calculations.' In the first, dissociation, ionization and the law of mass action are taken up. One can not help feeling that these sections are, as it were, dragged in, rather than that they form an integral part of the subject of which the book treats. This is especially the case when one finds, in close contiguity, the following, under the caption of superior chemical attraction as a cause of reactions: 'In the following, $HgCl_2 + 2KI = HgI_2 + 2KCl$, the K leaves the I and takes the Cl from the Hg, and the Hg and I, being set free together, unite.' Altogether, these first hundred pages or so of the book give little evidence of the advances that chemistry has made in recent years. Perhaps this would appear less conspicuous if the material were scattered through the book, as the author recommends when using the book for didactic purposes.

The remainder, some four fifths, of the book is taken up with 'Descriptive Chemistry.' The treatment of this subject is much more satisfactory. It is full enough for college classes, a good sense of proportion is observed in the amount of space devoted to the different elements and compounds, errors of statement and of typography are rare, and the material is brought well down to date. A considerable number of experimental illustrations are described, which would serve well for lecture or laboratory. The general arrangement of the elements is according to the periodic system, beginning with hydrogen and the inert gases of the eighth group, and then proceeding in order from the seventh group to the first, concluding with the metals of the eighth group. This order is occasionally departed from, as in the treatment of manganese in close connection with iron, and in discussing the atmosphere and combustion immediately after the carbon group. Thulium is placed with the halogens, samarium with manganese, and gadolinium between silver and gold, but as only a few lines are given to these rare elements, little harm is done. The nomenclature of the groups, though not absolutely new, is new enough to appear strange, for the halogens appear under the chloroids, group VI. is treated in the two divisions of the sulfoids and the chromoids, the inert gases under the heloids, etc.

For all those teachers—and they are many—who believe that the newer conceptions of physical chemistry should be reserved for students more or less advanced in general chemistry, Professor Hinds' book will be found an excellent text-book for a thorough course in inorganic chemistry.

'Chemistry by Observation, Experiment and Induction' is a laboratory manual prepared to accompany Hinds' 'Inorganic Chemistry.' The essential feature of the book is that under each experiment a series of questions is given, with spaces in which answers are to be written. The experiments are simple and well chosen. No quantitative experiments are introduced, but there is a considerable number of problems.

In both of the books the revised spelling is used.

If Dr. Hinds almost ignores in his book the newer physical chemistry, Dr. Jones goes to the opposite extreme in his 'Principles of Inorganic Chemistry,' and the book appears almost like a treatise on physical chemistry, copiously illustrated from inorganic chemistry. Yet all the essentials of inorganic descriptive chemistry are here, but viewed from the standpoint of physical chemistry. This book must be considered the most notable contribution to didactic chemistry produced by an American since the appearance of the Remsen series of text-books.

We have here a conscientious attempt to teach general chemistry purely from the standpoint of the newer chemical conceptions, and it doubtless gives us a little forecast of what will be the character of the chemical teaching of the future. The book, however, shows the dogmatic spirit which is characteristic of many of the physical chemists of to-day. Not only are the old ideas looked upon as completely overthrown, and their adherents as antiquated—this might be condoned—but the newer theories are treated as if in them the last words in chemistry have been uttered.

This tone is illustrated by a single quotation from the book before us: "The highest aim of scientific investigation is the discovery of wide-reaching relations between large numbers of facts. Such relations when sufficiently comprehensive are known as generalizations. *Beyond these we can not go*" (italics ours). A very considerable proportion of the studies of these physical chemists center around the theory of electrolytic dissociation, and this theory is invoked to explain practically all the phenomena of chemistry. Speaking of the fact that perfectly dry sodium does not react with perfectly dry sulfuric acid, Dr. Jones tells us that 'in terms of the theory of electrolytic dissociation and catalysis these facts are just what would be expected, and could have been predicted before they were discovered.' Ostwald shows that in the light of this theory all the reactions and procedures of analytical chemistry become simple and clear. On the other hand, we must remember that the theory itself applies with strictness, as far as it concerns solutions, to those solutions only which are at great dilutions, indeed in many cases to those of such dilutions as to be practically unattainable. The theory may be invoked to explain the phenomena of concentrated solutions, multitudinous reactions of organic chemistry, reactions which take place at high temperatures, and many others, but in these fields the applicability of the theory is largely a matter of conjecture. In other words, the theory of electrolytic dissociation is not the great, universal generalization we might imagine from the writings of some of its adherents. It represents a truth, but by no means the whole truth. In certain fields, as notably that of analytical chemistry, it is exceedingly useful, though even here it by no means explains everything. It does clear up many points which were formerly obscure. One can not help sometimes wondering if it is not leading chemistry fully as much back to the views of Berzelius, as carrying it forward into new fields, and whether it may not, like the dualism of the great Swede, some near day meet its Dumas. But even should this be the case, the work of the school of modern physical chemists is of inestimable value, and will always stand as one of the greatest advances in the development of chemistry. The dualistic theory of Berzelius was, after all, never really overthrown, but lives to-day in the theory of electrolytic dissociation. The mistake of Berzelius was in believing it applicable to all chemical phenomena. The physical chemist of to-day has found a key which fits many locks hitherto inviolable, but it has not yet proved itself to be the master-key.

In the preface to his book Dr. Jones says: "The aim of this book is to add to the older generalizations those recently discovered, and to apply them to the phenomena of inorganic chemistry in such a way that they may form an integral part of the subject, and at the same time be intelligible to the student. Why should we continue to teach the chemistry of atoms to students on the ground of its being a little simpler, perhaps, than the chemistry of ions, or on any other ground, if we know that it is not in accordance with the recently discovered facts? Or why should we continue to teach purely descriptive chemistry when the science of chemistry has outgrown this stage, and many of the most important relations have been accurately formulated in terms of the simpler mathematics? * * * If a student can grasp the conception of an atom and can not add to this the idea of the atom carrying an electrical charge, his hope of ever learning anything of chemical phenomena in general is not bright. * * * Why should chemists be hampered by being compelled to describe phenomena at length when these could be formulated in a single line? The time has come when they need not be, and the earlier elementary mathematics is introduced into textbooks on chemistry, the better for chemistry and for the chemist."

While thoroughly carrying out the spirit of the preface, the book is not, perhaps, as radical as might be expected. After opening with an introduction on elements and compounds and a chapter on the great generalizations of chemistry—the laws of conservation of mass, of constant proportion, of multiple proportions, of combining weights, the atomic theory and the correlation and conservation of

energy—an exhaustive study of oxygen is taken up, introducing the subjects of combustion, thermo-chemistry, the laws of Boyle and Gay-Lussac, absolute zero, liquefaction of gases, and closing with the experimental demonstration of the statement that 'the real difference in the properties of oxygen and ozone is due to the different amounts of intrinsic energy present in their molecules.'

The next chapter, on hydrogen and water, leads to the phase rule and electrolytic dissociation. The following chapters on determination of atomic and molecular weights contain also dissociation, the law of mass action, and the freezing and boiling point methods. Next comes an important chapter on osmotic pressure and the theory of electrolytic dissociation, written with excellent clearness. The conductivity method is here described. A chapter on chlorin brings up the conception of acids, of valence and Faraday's law. The subject of valence, or valency as the author calls it, has evidently been a difficult one to deal with. There is clearly an effort to confine valence solely to the ions, and structural formulæ are completely tabooed throughout the book. It would be rather rash to cut loose from structural formulæ in organic chemistry, but if they represent a truth in one field, they represent a similar truth in the other. It is true that structural formulæ have been fearfully misused and abused in inorganic chemistry, but this is no reason for completely abandoning their use and confining valence to the ion alone. The author is quite consistent, but he has thrown away a useful piece of scaffolding before the walls of his building are complete.

The periodic system is the next topic, and is well treated. We can not help thinking that some of the imperfections which the author finds would disappear if Venable's modification of the table were used. This is particularly true of the difficulty in making sodium a member of the copper, silver, gold group, and that of grouping fluorin with manganese instead of with the halogens, where it evidently belongs.

From this point on, the elements are studied in the order indicated by the periodic table. The other halogens are followed by sulfur, under which the temperature-pressure diagram is considered, and, in connection with hydrogen sulfid, reversible reactions. After nitrogen comes a chapter on neutralization of acids and bases, and another on the atmospheric air, including the inert gases. Under carbon dioxid we find a discussion of critical temperature and the continuity of the liquid and gaseous states, as well as a brief outline of the kinetic theory of liquids. The section on the rôle of carbon in producing light is particularly good.

After completing the metalloids (the author uses this term very sparingly, and the term non-metals not at all, as far as we have noticed), the metals are taken up, beginning with those of the alkalies. The purification of sodium chlorid gives occasion for a consideration of the application of the law of mass action to ions, and the sodium halids are used to show the transition point on their solubility curves. The phase rule finds a good illustration in the dissociation of calcium carbonate. Under zinc is an extended discussion of primary batteries and solution tension. That the book does not overlook practical applications of the subject is evidenced by nearly two pages on phosphate fertilizers and their analysis, and by a clear, if brief, treatment of iron and steel manufacture. Iron also leads to a consideration of oxidation as a method of ion formation, and of chemical action at a distance. Change of color with change in electrical charge is exemplified by the iron cyanids, and the color of ions by the permanganates. Under uranium, radio-activity is taken up, and under copper, ion formation in substitution reactions. Photography is outlined under silver; gold furnishes an example of ion formation from contact of molecules and also of colloidal solutions. This last subject is more fully taken up under platinum, where the work of Bredig is noticed.

We have thus gone rather minutely over the contents of the book because it represents somewhat of a pioneer attempt to treat inorganic chemistry from the standpoint of physical chemistry, and this necessitates presenting a pretty full outline of physical chemistry

itself. The attempt is interesting and, we must admit, very successful. The only serious omission we note is that of double and complex salts. There is a brief reference to the double mercuric iodids, a paragraph on alums, some discussion of double cyanids and chloroplatinates, but no consideration of double salts from a theoretic standpoint nor any mention of Werner's hypothesis. When one considers the number, variety and importance of double salts, he can not but feel that this omission is a defect in a book of this scope.

The book will be interesting and profitable reading for every teacher of chemistry, nor should any advanced student of chemistry fail to go carefully through it. It will be particularly valuable for those teachers whose student days were before the reign of the present physical chemists. How the book will fare as a text-book remains to be proven. In the judgment of the reviewer it would make a hard task for a beginner and should only be used for students who have a considerable knowledge of descriptive chemistry. With this view, however, the author of the book evidently differs.

The book is well gotten up, the type is clear, and the proof-reading has been almost perfectly done; the illustrations, though not numerous, are mostly new and really illustrative, and the book closes with a copious index. One other commendation must not be omitted. The style of the author is excellent. It is clear, never heavy, and at times almost conversational. This makes the book easy reading. Some may object to the author's enthusiasm; we do not. We like to read of the 'beautiful investigations' of Moissan with the electric furnace, we like to hear Wöhler called the 'great' German chemist, and we appreciate a book the better whose author is not so much engrossed with theory but that he can close its pages with the words, speaking of magnesium plato-cyanid: 'It is questionable whether another compound of equal beauty is known in the whole field of chemistry.'

The last book before us, that of Professor Holleman, of the University of Groningen, was first published in 1898, and two years later a German translation appeared. The English translation has the further advantage of having been completely revised by the author, so that it is practically a revised edition.

This book bears in many respects a marked resemblance to that of Dr. Jones, so much so, indeed, that it would be superfluous to give an extended review of it. The aims and the scope of the books are the same, the methods used are similar, and the order in which the different subjects are taken up does not differ materially. Holleman's book lacks wholly the dogmatic atmosphere we have noticed in that of Jones, but it also lacks the enthusiasm of the latter, although it is very readable. Holleman treats the principles of physical chemistry rather more fully than Jones, and he introduces more mathematics, though the mathematics used is always elementary. It seems as if this makes the subject matter simpler and clearer, but many may think otherwise. Holleman is also fuller in his treatment of subjects connected with practical and technical chemistry. Taken altogether, it is impossible for the reviewer to decide which book would probably prove more successful in the class room, but both will prove very helpful to a teacher.

There is not quite the same freedom from errors that is found in Jones's, and it is occasionally evident that the book was not originally written with reference to use in America. This is particularly true in some cases of metallurgical practice. The translation is exceedingly well done, and does not read like a translation, though now and then expressions creep in which reveal the fact, as well as others which are English rather than American. For example: 'it is not supplied with a steam pipe either'; 'ferric hydrate serves as a counter-irritant' (for arsenic); 'silicon trichloride is obtained as a side-product'; 'SnS falls down as a powder'; 'SnS_2 falls out as a powder'; 'it (minium) has a pretty red color'; 'soda crystals weather,' and efflorescence seems invariably to be spoken of as weathering; 'having very different properties than liquids,' and 'than' is frequently used after 'different'; 'axles of railway carriages'; 'metallic crustations'; 'it dissolves without

generating scarcely any chlorin'; titanium, zirconium and thorium are spoken of as 'uncommon' elements.

But if these are the worst criticisms that can be passed upon the book, and this is perhaps the case, it must be conceded that both author and translator have done their work in a very satisfactory manner, and we have no doubt but that Holleman, as well as Jones, will find its way into many class-rooms and will also prove to be but a pioneer of an improved type of text-book, which will revolutionize the teaching of inorganic chemistry. And for this let us be devoutly thankful.

JAS. LEWIS HOWE.

WASHINGTON AND LEE UNIVERSITY.

A Text-book of Zoology. By G. P. MUDGE. London, Edward Arnold. 1901. Pp. viii + 416.

The author of this book is lecturer on biology at the London School of Medicine for Women, and on zoology and botany at the Polytechnic Institute, Regent Street, and is also demonstrator in biology at the London Hospital Medical College. His text-book may, therefore, be presumed to be an expression of the practice of an experienced and active teacher of biology. It differs markedly in matter and arrangement from the usual zoological texts, arranged systematically, that is, according to the accepted classification of animals. In a first part are an interesting introduction called 'the scope of biology' and a brief statement of 'the characters of the great divisions of the animal kingdom,' in which Protozoa, Metazoa, Acœlomata, Cœlomata, Vertebrata, Invertebrata, Diploblastica and Tripoblastica are defined. Then comes a second part given to a study of 'the comparative morphology of the organs of *Scyllium, Rana* and *Lepus.*' The organs of these three vertebrates are discussed on the plan of the comparative anatomist, the condition of each organ or system of organs being compared in the three forms. This discussion covers one hundred and sixty-seven pages, and is illustrated by fifty-two diagrammatic figures. To this part is added a chapter of twenty-two pages on the morphology of *Amphioxus.* A third part, of sixty-eight pages, is given to the morphology of four cœlomate invertebrates, viz., *Astacus, Periplaneta, Anodonta* and *Lumbricus,* the treatment being again that of the comparative anatomist. Then comes a chapter on 'the morphology of *Hydra,*' an acœlomate invertebrate, and a chapter on 'the morphology of *Paramœcium* and *Amœba.*' The fourth part of the book is composed of a chapter on 'embryology' (38 pp.), one on 'the life history of the cockroach and the butterfly, and their chief structural differences' (9 pp.), one on 'karyokinesis, oogenesis and spermatogenesis, maturation and impregnation of the eggs, and parthenogenesis' (10 pp.)!—the author is seeing the limits of his permitted space; then one on 'heredity' (26 pp.), and finally one on 'variation' (15 pp.).

When one departs from the usual and presumably approved manner of make-up of zoological text-books, the real court of appeal for the final decision as to the worth of the new manner is that composed of teachers who have tested in actual class work the usefulness and practicalness of the innovation. Thus does the reviewer easily put aside the necessity of expressing an opinion about the matter. He will hazard the guess, however, that most present-day teachers of zoology will not choose a text-book of comparative anatomy under the name of a text-book of zoology for their first-year classes.

The work outlined in the book is sound and thorough, and the discussions of heredity, variation and the scope of biology are modern and interesting. The book is compact, well-made and fully indexed. V. L. KELLOGG.

Lehrbuch der Zoologie. By ALEX. GOETTE. Leipzig, Wilh. Engelmann. 1902. Pp. 504; 512 figs.

The author of this zoological text-book is professor of zoology in the University of Strassburg. The book is intended for university classes; it is of the reference or manual of classification type of text-book, not of the laboratory guide or specifically outlined course type, as is the English text-book reviewed above. After twenty-five pages of introduc-

tion, defining homology, analogy, etc., and describing protoplasm, the cell, etc., and mentioning some names and dates in the history of zoology, the rest of the book is arranged according to the present classification of animals, beginning with the Protozoa, and systematically discussing systematic zoology with orders and sometimes suborders for units. The systematic consideration of the Metazoa is preceded by a fifty-page discussion of the tissues, organs and development of the many-celled body.

Where all animals are touched on none can be adequately considered. Text-books of zoology which get in the name of every order of living animals are misnamed; they are dictionaries of systematic zoology, catalogues of the animal kingdom. The beetles, of which there are 12,000 known species in North America—and how many thousand in the world?—with a variety of form and habit comparable in extent with that of the endless pattern pictures of a busily handled kaleidoscope, get one page and one figure of this book. Three fourths of this page are given to dividing beetles into four suborders. Why not make it one line, and be more truly and just as effectively a catalogue and less a pretense of being something else? The rest of the page could then go to the needed expansion of the account of the special structure and physiology of the class of insects. The student who is going to study beetles beyond the name Coleoptera has no possible use for one page and a subdivision into four suborders. He must have thirty pages and half of the families if he is to go a single step forward in their systematic study, or as many pages as he can have, with no subdivision, if he is to get a glimpse of their life and habits. The author, in trying to get all the animals catalogued in his 'Lehrbuch,' makes of it no text-book at all, and a sort of catalogue vastly inferior to a professed synopsis like Leunis's.

V. L. KELLOGG.

L'Hypnotisme et la Suggestion par le Dr. Grasset. Paris, Octave Doin. 1903. 8vo. Pp. 534.

The culmination point of the contributions to the literature of hypnotism was reached quite a number of years ago. There was a period when the contributions to this topic quite overshadowed those to any other division of abnormal psychology. Dessoir issued in 1890 a supplement to his bibliography of hypnotism first issued in 1888, and recorded nearly four hundred titles to the credit of these two years.* The more recent contributions that have been comprehensive in scope have likewise been more selective in purpose. Some have been devoted to the analysis and description of the psychology of suggestion; others to the therapeutic applications; others to the analogies between that and other states normal and abnormal. As a number of the International Library of Experimental Psychology now appearing in fifty volumes under the editorship of Dr. Toulouse, there has appeared a volume on 'Hypnotism and Suggestion,' of which the author is Dr. Grasset, of the University of Montpelier. As the representative of this library, the volume on hypnotism will command wider attention than would be accorded it as an independent contribution.

It can not be said that the volume, though it compares favorably enough with many others that have appeared, really adds much of note or illumination to the present status of the subject. It does, indeed, bring forward with a fair sense of their relative importance the several problems that are most worthy of attention in contemporary psychology. It wisely dispenses with much introductory or historical matter, which in former compends found a somewhat undue place. It recognizes that the fundamental problem, the

* Beginning with 1896, the number of entries for this group of topics in the 'Psychological Index' is 51, 84, 154, 143, 77, 35, 35, 28. These numbers are not comparable, since the falling off in the more recent years is in part due to a subdivision of the topics that bring 'Hypnotism' into a separate division in the later but not in the earlier years. Parallel with this, there is some widening of the scope of the 'Index' since its foundation. None the less, the 'Index' shows the general falling off in the productiveness of this topic. Such falling off is a welcome consummation, so far as it represents the cessation of wordy and unorganized—not to say amateur—contributions.

solution of which will determine the status of hypnotism, of suggestion and of other varieties of mental states, is the problem of the subconscious and its relation to the ordinary form of mental action. Dr. Grasset's solution of this problem, or rather his attitude towards it, is not helpful. His discussion thereof is more like a logomachy than a psychological analysis, and his use of his favorite diagram decidedly illogical. He accepts the hypothesis, now current in such diverse forms, of two separate forms or types of psychic expression; by the letter *O* he designates the superior form of psychic action or the highest center; the *O* stands at the apex, and dependent thereon and with connections between them, are the members of the group of inferior psychic centers arranged in the form of a polygon. By this painfully artificial representation the words 'polygonal' and 'suspolygonal' become synonymous with subconscious and subvoluntary sources of action. We read of the 'dissociation of the polygon' of the individual, of 'polygonal spontaneity,' of 'polygonal patients or maladies' and other confusing and absurd expressions. This type of logicality is hardly pedagogical. It must also be added that the author's attitude towards many other questions of fact and interpretation are far from commendable. His reference to the independence of the action of the two hemispheres of the brain as proven by the phenomena of hypnosis, and his acceptance of questionable hypotheses in regard to the nervous substrata of hypnotic behavior, are instances in point. His entertainment of the hypothesis of telepathy and clairvoyance —though he believes that neither of these is proven—suggests weakness of grasp of their status, rather than judicial toleration.

The author's main positions are these: that there is a real hypnotic state, distinct from suggestion, marked by independent physical signs as well as by increased suggestibility; that the source of this state is in the dissociation or disaggregation of the subconscious psychic mechanism; that though normally the higher and lower psychic centers act in complexly coordinated, unified manner, in abnormal states—of which hypnosis is one great type—they act separately; that hypnosis does not present sufficient analogies to sleep or to any normal mental state to be affiliated with it or interpreted by it; that a significance may be given to spiritistic or mediumistic phenomena analogous to the various states and types of hypnosis; that the phenomena of normal suggestion, which in the conception of the Nancy school is made almost synonymous with the acquisition of ideas, are not truly analogous to the increased suggestibility characteristic of the true hypnosis. These are all debatable positions that yet await a more competent master to set forth their bearing and value for experimental psychology. Dr. Grasset contributes something of value to the consideration of these positions, but not what one has a right to expect of a volume that is presented as authoritative in character. It only remains to add that there are the usual chapters upon the medical and legal aspects of hypnotism, and interesting, though somewhat prolix and not properly systematized presentation of the facts of hypnotism, and a better index than the average of French books offers. It is to be hoped that the further volumes of this series, the contributors to which include a few American names, will meet a higher standard. The ten volumes already published give the impression of very unequal care in their preparation and merit in their authors. Some of the volumes are distinctly commendable. May the rest prove to be so!

J. J.

SCIENTIFIC JOURNALS AND ARTICLES.

The Plant World for April contains the fifth of the 'Extracts from the Note-Book of a Naturalist on the Island of Guam,' by W. E. Safford. 'Monocotyledons or Dicotyledons,' by J. Arthur Harris, calls attention to the fact that there are some plants whose position in this respect is very puzzling, and briefly discusses the question which of the two forms is the older. George V. Nash describes 'The Palm Collection at the New York Botanical Garden,' and there is much of interest in the section on 'The Home Garden and Greenhouse.'

Bird Lore for March–April has the story of 'A Sierra Nighthawk Family,' by Florence M. Bailey, and of 'A Family of Barn Owls,' by Thomas H. Jackson; an important brief article on 'The Heath Hen in New Jersey.' Anna Head describes the 'Nesting of the Ruby-crowned Kinglet' and Frank M. Chapman gives the third paper on 'How to Study Birds,' this being devoted to the nesting season. There is the third series of portraits of *Bird Lore's* Advisory Councilors. There are the customary notes, reviews and reports of the Audubon Societies, from which we learn of the spread of bird protection in various states.

SOCIETIES AND ACADEMIES.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 567th meeting was held on April 11, 1903. Professor Marvin exhibited a seismograph sheet showing a slight earthquake wave on March 15. Professor Gore described the 'International Bibliography of Mathematics' now published at irregular intervals in card form. Thus far eleven sets of one hundred cards each have been published.

Professor T. J. J. See, U. S. Navy, read a 'Historical Sketch of Olaus Roemer, the Discoverer of the Velocity of Light.' Roemer was one of the greatest scientific geniuses, ranking with Aristarchus of Samos, Archimedes and Hipparchus, among the ancients, and with Galileo, Newton and Bessel, among the moderns. As almost all of his observations were consumed in the conflagration which destroyed a large part of Copenhagen in the year 1728, his memory has been greatly neglected. Yet it was Roemer who invented all the principal instruments of the modern observatory—the meridian circle, the prime vertical, the altazimuth and the equatorial telescope. He lived very much in advance of his age.

The discovery of the velocity of light in 1675 was treated at length. It was made from the eclipses of the first satellite of Jupiter. Most of Roemer's contemporaries rejected his theory of the finite velocity of light, or adopted it only after long years had elapsed. The French men of science were slower in accepting the new idea than men of science in other nations. Huygens and Newton adopted Roemer's results, while Fontenelle, the perpetual secretary of the Paris Academy of Sciences had even gone so far as publicly to congratulate himself on escaping the seductive error of believing in the gradual propagation of light! Roemer gave eleven minutes for the equation of light (time in coming from the sun to the earth), but Newton reduced the value to between seven and eight minutes. The true value found by the classic researches of Michelson and Newcomb is about 8.4 minutes, to which Newton's was a close approximation.

The speaker said that with the exception of the discovery of the law of gravitation, no sublimer discovery than that of the velocity of light had ever been made. Notwithstanding the incredulty of others, Roemer had never wavered in his belief in this discovery, and the speaker said that it paved the way for the investigation of the velocity of electricity, which had been found with much accuracy.

Roemer was born in 1644 and died in 1710, all of his life except nine years being spent in Denmark. He met Picard when he came to Denmark to determine the position of Tycho Brahé's Observatory in 1671, and the following year returned with him as his assistant, and spent nine years at the Paris Observatory, just started under J. D. Cassini. Picard was much the best astronomer of his age, but had been set aside by the government of Louis XIV., and a foreigner, Cassini of Bologna, called to be superintendent of the Royal Observatory at Paris. This circumstance injured astronomy in France for many years. Roemer's association with Picard was fortunate, as this gave him the best ideas of the times, though his own genius was even greater than that of Picard, who had acquired an imperishable reputation by measuring the arc of the meridian used by Newton for verifying the theory of universal gravitation in 1685.

A picture of Roemer was exhibited, kindly sent by Professor T. N. Thiele, director of the Royal Observatory of Copenhagen. This showed a striking resemblance to Newton.

The paper will be published in an early number of *Popular Astronomy*.

Dr. A. L. Day, of the Geological Survey, discussed 'The Melting Point of a Glass,' basing his remarks on a study of borax glass, which has a melting point in the neighborhood of 730° as determined in ordinary ways. If ordinary solid bodies have heat communicated to them the temperature gradually rises till melting begins, when it remains stationary till melting is complete; and a corresponding phenomenon takes place on cooling from liquid to solid. So the curve of temperature as a function of the time shows a portion parallel to the axis of the time. The borax glass, if in the crystalline state, shows a similar straight portion, or at least a departure from the smooth curve; but if in the vitreous stage the curve may be perfectly smooth, and the material pass from liquid to solid without showing any phenomena by which to fix a melting point, as ordinarily defined.

THE 568th meeting was held April 25, 1903, in the rooms of the National Bureau of Standards through the courtesy of Director S. W. Stratton. No formal papers were presented, but the laboratories and shops were opened, and many new instruments were exhibited and explained informally. The evening was one of great interest to all visitors.

CHARLES K. WEAD,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 371st meeting of the society was held on Saturday, April 18.

W. J. Spillman spoke on 'Agrostological Problems in the United States,' using a number of lantern slides by way of illustration. These slides were prepared from the recent census reports, and showed the distribution of each of the important hay and forage crops over the country. He brought out the rather remarkable fact that by far the larger part of the hay and forage produced in this country is produced on the glacial drift, also that one fourth of the total hay and forage is produced from wild grasses, and that of the wild grasses that are thus utilized no one of them has as yet been brought into cultivation. The principal reason for this lies in the poor seed habits of these grasses, a fact which renders their use impracticable. He also gave some illustrations of the relation between certain crops and certain geological formations. It was shown that, in the state of Kentucky, Kentucky blue grass (*Poa pratensis*) is confined to a circular area in the northern part of the state, in which the dolomitic limestones of the Silurian outcrop. In a similar manner Johnson grass in the southern states is more or less closely confined to the soils of the Cretaceous. He pointed out the importance of increasing the areas of hay and forage crops, particularly in the cotton belt, where the system of farming has depleted the soil of humus to such an extent as greatly to interfere with its productivity. He stated that another very important problem was to secure suitable crops for the arid and semiarid regions that could be grown without irrigation, and that some progress has been made in this direction.

A paper by Basil Dutcher, captain U. S. Army (Medical Corps), on the 'Mammals of Mount Katahdin,' was read by Vernon Bailey. The topography of the region was carefully described, and this was followed by a fully annotated list of the mammals. Of the larger species the moose was fairly common, the Virginia deer abundant, while the otter and lynx were still found in the vicinity. Small carnivores, the fishes, mink and weasel were said to be common, but Mr. Dutcher was able to trap but few small rodents, the only really abundant rodent being the muskrat. The fauna was that of the Canadian region, and not that of the Hudsonian.

In his paper, entitled 'Notes on the Dissemination of *Sedum douglasii* by Proliferous Shoots,' Mr. V. K. Chesnut drew attention to a comparatively undescribed natural method of plant reproduction. *Sedum douglasii*, a plant growing at an altitude of about 7,000 feet in Montana, forms axillary branches about a half inch long, which, late in the summer, become detached from the dried stem after the plant has flowered, and which are capable of reproducing the plant vegetatively. The light, spear-shaped branches

are blown about by the wind, remain dormant under the snow through the long winter season, and, if the proper conditions are present, take root in the soil the following spring. The mechanical structure of the shoots which enables the plant thus to disseminate and to perpetuate the species was described and illustrated by specimens and by photographs.

F. A. Lucas.

THE GEOLOGICAL SOCIETY OF WASHINGTON.

At the 142d meeting of the society, held in the assembly hall of the Cosmos Club, Wednesday evening, April 8, 1903, the following program was presented:

Mr. J. E. Spurr, 'The Relation of Faults to Topography.'

Folds and faults are closely associated genetically, and their effect on the surface relief is analogous. Each may be divided into three orders:

1. Those affecting great areas, as portions of continents.

2. Those affecting broad belts, producing mountain systems.

3. Folds and faults proper, being wrinkles and fractures on the grander flexures and displacements of the first and second orders.

Gravity antagonizes these disturbances, in so far as they affect surface relief. On account of the relative bulk of material to be readjusted, and for other reasons, erosion is generally ineffective in combating flexures and dislocations of the first and second orders, while folds and faults proper are generally overcome. So the anticlinal ridge and the synclinal valley of direct deformation are relatively rare as compared with the anticlinal ridge, the synclinal ridge and the anticlinal valley of erosion. Similarly, the speaker's studies have convinced him that the analogous features of relief connected with faults have about the same proportion. Simple fault-scarps (analogous to ridges and valleys of direct deformation) are relatively rare; while normal erosion fault scarps and reversed erosion fault scarps (analogous to anticlinal and synclinal ridges of erosion) are about equally abundant. The forms *indirectly* expressed on the topography by the erosion of folded and faulted rocks also differ in different climates.

Mr. Waldemar Lindgren, 'Metallic Sulphides from Steamboat Springs, Nevada.'

During a visit to Steamboat Springs in 1901, it was found that a shaft forty feet deep had been sunk through the sinter deposits near the railroad station. Below the sinter, a gravel of well-rounded granitic and andesitic pebbles was found, and in this gravel, which is probably an older deposit of Steamboat Creek, minute needles of well-crystallized stibnite were found to be very abundant. The gravel also contains well-crystallized pyrite, and some opal often coats the surface of the pebbles. From the investigations of Dr. Becker it is known that the sinters contain sulphides of arsenic and antimony, but no well defined or crystallized minerals corresponding to these salts have previously been found. Since the gravels in which the crystallized stibnite and pyrite occur seem to be free from the sulphide of arsenic which is found in the overlying sinters, it is inferred that the conditions of deposition in the two cases are different.

Mr. Geo. I. Adams, 'Origin of Bedded Breccias in Northern Arkansas.'

The fracturing and brecciation in the northern Arkansas zinc and lead district are probably due to stresses induced at the time of the folding in the Ouachita Mountain and Arkansas valley regions. At the close of the Carboniferous period the thick mass of sediments which had accumulated in what is now central Arkansas and western Indian Territory was deformed in a manner which suggests that the beds were thrust to the northward. In the Ouachita Mountains there are close folds and thrust faults; in the Arkansas valley region, open folds. In the southern border of the Ozark region, and particularly in the zinc and lead district of northern Arkansas, the generally horizontal position of the rocks was retained, but there was considerable movement of individual beds, especially in the Ordovician series. The variation in the structure of the Ordovician dolomites, which are in places massively bedded and in other places thin-bedded, lamin-

ated and even shaly, resulted in the lateral movement being taken up in varying degree by the individual beds, so that the motion was such as is produced by forces acting in couples. The brecciation is due to the tendency of the pieces, resulting from the breaking of certain brittle strata, to shear past each other, or to rotate with the horizontal movements of the adjacent beds, so that the fragments are relatively displaced.

Mr. E. C. Eckel, 'Dahlonega Mining District, Georgia.'

The country rocks in the Dahlonega district in Georgia are mica schists and gneisses of pre-Cambrian age, including possibly some metamorphosed Paleozoic. These early rocks are cut by diorites and granites; the former highly sheared, the latter but slightly gneissoid. The gold-bearing quartz veins occur along the contacts of the diorites or granites with the mica schists. The veins show but little deformation, and the epoch of vein formation, as well as of the intrusion of the granites, is therefore thought to be not earlier than the Ordovician. This view is confirmed by the occurrence of gold veins in the Ocoee (Cambro-Silurian) rocks of Georgia and Tennessee, and in Ordovician rocks in New York.

W. C. MENDENHALL,
Secretary.

NEW YORK ACADEMY OF SCIENCE. SECTION OF GEOLOGY AND MINERALOGY.

A REGULAR meeting of the Section of Geology and Mineralogy was held at the American Museum of Natural History on the evening of March 16. In the absence of Professor Kemp, Dr. Julien was made temporary chairman.

The first paper was by Dr. A. W. Grabau on the 'Geology of Becraft Mountain, New York.' Becraft Mountain, in Columbia Co., N. Y., is an outlier of the Helderberg Mountains. Its base is formed by the upturned and eroded rocks of the Hudson Group, chiefly the Norman's Kill shales. Unconformably upon this rests the upper part of the Manlius limestone, followed in turn by the members of the New York Devonian up to and including the Onondaga limestone. The structure of the eastern and southern portion of the mountain, which is of the Appalachian type, was discussed, and the excessive folding and faulting upon it illustrated by maps and sections. The paper was discussed by Dr. Stevenson and by Dr. Julien.

The second paper, by Mr. C. W. Dickson, was entitled 'The Mineralogy and Geology of the Sudbury Ontario Copper Nickel Deposits.'

It was shown that by magnetic concentration of the ore nearly all the nickel can be eliminated from the pyrrhotite, proving that the element is present in a separate mineral and that it does not replace part of the iron of the pyrrhotite isomorphously. The economic concentration of the nickel by magnetic methods is, however, practically impossible. The composition of the nickel mineral corresponds closely to that of pentlandite, but there is always an excess of $(Fe + Ni)$ over that required by the formula $(Fe + Ni)S$ in the proportion 11:10.

After studying the relations of the ore and rock minerals in the field and by the aid of the microscope, the conclusion was reached that the deposits are replacements along crushed zones through which the mineral-bearing waters circulated, and that they can not be original magmatic segregations, as generally held.

GEORGE I. FINLAY,
Secretary pro tem.

ELISHA MITCHELL SCIENTIFIC SOCIETY.

THE 148th meeting was held in the chemical lecture room, University of North Carolina, April 14, 7:45 P.M.

The following papers were read:

'The Prices of Anthracite Coal in the United States, 1850–1902,' by Professor C. L. Raper.

'Habits of North Carolina Woodpeckers,' by Mr. Ivey F. Lewis.

'Note on Imaginary Roots of a Cubic,' by Professor Wm. Cain. Certain characteristics of the graphs of functions of the third degree were established and easy tests found (not

involving the discriminant) to ascertain when cubic equations had imaginary roots.

CHAS. BASKERVILLE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ECOLOGY.

TO THE EDITOR OF SCIENCE: I read with much interest Professor Fernow's article, bearing the above caption, in SCIENCE, April 17, an article attractively written and containing many valuable suggestions.

I do not propose to enter into the general discussion outlined by the author, but shall confine myself to the paragraphs on the soil. It would not be right to allow so misleading a statement as 'it is first of all to be considered that chemical constitution [of the soil] plays probably only a small part or practically none; the reliance of tree growth on mineral constituents being relatively small' to go without protest.

The chief fact that is adduced in support of this dictum rests on the small percentage of ash in the grown tree and its greater abundance in the leaves and younger growth.

The growth of a tree is as absolutely conditioned by 'mineral constituents' as by any other fundamental factor of the environment. Vines says: 'Thus the inorganic substances absorbed by the roots pass into the cells of the leaves where they are concerned in the processes of constructive metabolism which are in operation in those organs.'

It is apparent that without this 'constructive metabolism' the materials of which the chief part of the plant is composed, mostly carbohydrates, could never be provided.

One of the functions of the absorption of water as such by plants is to secure the translation of these mineral elements from the soil to the parts of the organism where their constructive work is to be done.

Vines says: 'Only very dilute solutions of salts can be taken up by the roots; as a consequence, it is necessary that relatively large quantities of water should be absorbed in order that the plant may be supplied with the salts which are important in nutrition.'

The tree, during the whole period of its growth, does not use from without a single organic product. It gets its nitrogen in the form of nitric acid, its carbon in the form of carbon dioxid, its phosphorus in the form of phosphoric acid, its hydrogen in the form of water, and so on to the end of the nutrients. The fact that mineral matters are exuded in the leaves is no proof that they have not performed or assisted in performing the most important physiological functions. The excretion of a 'mineral constituent' may even be a proof of its importance in metabolism, as is the case with a great part of the phosphorus that is excreted from the body. Nature is careful to provide a superabundance of the most important substances. Because a tree may take up only one millionth part of the carbon dioxid which comes to it in the air during its period of growth, is no reason for saying that this constituent of the air is of little consequence in biodendry.

Mineral substances not only are useful and necessary in plant growth because of their part in forming tissues, but also because they stimulate by their presence the functional activity of the vegetative cells. In other words, they are condimental or katalytic as well as constitutional. Although potash is not a constituent of starch, it is thoroughly established by indubitable evidence that in the absence of potash in the plant blood starch granules are not formed.

The ions of mineral matter taken from the soil and coursing through the circulating apparatus of the tree perform useful and necessary functions from the time they enter the waiting mouth of the rootlet until they congregate in the extremest tip of the reddening leaf.

The 'mineral hunger' of plants is as well known and recognized by physiologists as that of animals, and the welfare of the growing tree is undoubtedly as profoundly affected by the soil element of its environment as by any other. Experiments have shown the minimum of any given mineral element of the soil which will permit normal development, but such a minimum only does so in case other mineral

elements are in excess. If the minima of all mineral elements are presented to the plant at the same time, normal growth can not take place.

In the experiments of Wolff it was conclusively shown that in such cases flowering and fruiting are practically prevented. The plant has, therefore, need of an excess of mineral matter, and this is secured from other mineral substances if one of the essential minerals is present in a minimum quantity. Thus some mineral foods may, temporarily at least, act as substitutes to a certain degree for others. Strange to say, however, sodium, which is so near potassium in its general properties, has but slight, if any, suitability as a substitute therefor. It is a mistake, therefore, to look upon the constitutional assimilation of mineral matters as their chief utility. The fact that both potash and phosphorus are always associated with the functions of the living cell is not to be forgotten. The absence of either of these minerals makes vegetable growth impossible. Especially are these two substances the katalytic agents whereby the living cell converts the other mineral foods of plants into starch, sugar, cellulose, oil and protein, of which the organic parts of plants are chiefly composed. These elements reach the tree solely through the soil, and the greater or less abundance of them in the soil can not fail to affect profoundly forest growth, perhaps to a greater extent than almost any other factor of the environment.

The soil has, therefore, marked ecological as well as physiological influences on forest growth. The soil of the forest is nature's own handiwork and will never be modified by man. When man begins his work the forest ends and the park begins. We all know how the soil alone has, in many instances, determined the character of tree growth. It is not wholly accidental that the sands are covered by pines and the mountains by oaks. The virgin forests in many localities were indexes whereby the early settlers selected their entries of land. They did not need to be told that the maple, the walnut and the tulip grew on the richer, and the beech, the gum and the oak on the poorer soils. The first forests that fell before the ax were those of the first-named trees. Thus the nature of the soil has often determined the original distribution of forest growth. Nature seems to know the edaphic principle in ecology better than man.

It is to be regretted that at this late day we should be told by such an eminent authority: 'Moreover, the total amount of mineral constituents in a tree is not only very small, but by far the largest portion is found in the leaves and young parts, suggesting again their merely fortuitous presence as a residue of the transpiration current, and mostly not required.'

I need hardly add the observation that the presence of mineral substances, both as such and as salts of the organic acids, profoundly modifies osmotic pressure, and without the aid of these substances the 'transpiration current' would never reach the tips of the trees, but, like the vanishing stream of the desert, be forever lost. The incidental fact of peripheral accumulation of mineral matter due to transpiration seems to have no bearing on the previous utility of the accumulated material during its passage through the cellular substance of the tree.

H. W. WILEY.

ARE STAMENS AND PISTILS SEXUAL ORGANS?

IN SCIENCE, XVII., 652, Professor W. F. Ganong suggests that stamens and pistils are sexual organs, and gives some interesting reasons for this conclusion. In brief, he proposes to abandon the morphological point of view and adopt one purely physiological. It must be admitted that a genuine argument is presented here, but it is still open to question whether such a use of terms conduces to clearness. If the stamens are male organs, I suppose their product, the pollen spores, must be regarded as male cells. And if the pistil is a female organ, I suppose the scattering of pollen spores upon the stigma must, if one is consistent, be considered as a sexual act and, in that case, may be termed, as Mueller did, 'Befruchtung.' But to the mind of a morphologist this confusion of the processes of pollination and fecundation is extremely ob-

jectionable. The phylogenetic history and the ecological significance of the two processes are totally different.

Since the appearance of Goebel's 'Organography' it has been the fashion to urge the morphologists to be humble, but it is not impossible that a clear definition of terms in accord with the facts of phylogeny, such as morphologists have insisted upon, may still be of some value to botanical science.

When it is so easy to use such terms as 'staminate' and 'pistillate,' it seems a pity to permit flowers to be called 'male' and 'female.' CONWAY MACMILLAN.

PATAGONIAN GEOLOGY.

UNDER the title 'L'age des formations sedimentaires de Patagonie,'* Dr. F. Ameghino has issued a collection of papers relating to this subject published originally in the *Anales de la Sociedad Cientifica Argentina,* Vols. 50–54 (1900–1903). The chief purpose of this series is to refute the views on Patagonian geology expressed by Mr. J. B. Hatcher and myself.

Unfortunately, the representation of my statements as given by Ameghino is in almost every single case more or less inaccurate, sometimes my views are not properly understood, sometimes they appear distorted and even directly altered.

Since it is not worth while to correct all these misunderstandings—this correction being merely a reiteration of what I have said before—I do not think it necessary to go into detail. I only wish to caution any subsequent writer occupying himself with the question of Patagonian geology, not to rely implicitly on Ameghino's representations of my views and statements, but always to consult the original version of them, as laid down in the final report on the 'Tertiary Invertebrates of the Princeton Expedition.' †

A. E. ORTMANN.

PRINCETON UNIVERSITY.

* Buenos Aires, 1903.

† 'Reports of the Princeton University Expeditions to Patagonia,' vol. 4, part 2, 1902.

NOTES ON METEOROLOGY.

METEOROLOGICAL REPORTER TO THE GOVERNMENT OF INDIA.

SIR JOHN ELIOT, who has for a number of years occupied the important position of meteorological reporter to the government of India, and who received the distinction of knighthood on the occasion of the Durbar at Delhi, is to resign at the close of the present year. Mr. Gilbert T. Walker, who has been appointed Assistant Meteorological Reporter to the government of India, is to succeed Sir John Eliot on the latter's retirement. Mr. Walker is a fellow of Trinity College, Cambridge, where he attained highest honors in mathematics, and where he has taught mathematical physics since 1895. He has published a number of important researches on electricity and magnetism. After his appointment to the position of assistant meteorological reporter, Mr. Walker came to the United States, where he made a study of our methods of work in astronomy and in meteorology, visiting the Harvard and the Yerkes astronomical observatories, the Blue Hill Meteorological Observatory, the Weather Bureau in Washington, etc. Mr. Walker sails for India early in May. With his admirable training in mathematics and physics, his great ability to pursue original investigations along these lines, and his wonderful field for work in Indian meteorology, there is no doubt that Mr. Walker will make important contributions to our knowledge of the mechanics of the earth's atmosphere. He may be assured that he takes with him to his new field of labor the best wishes of American men of science for his success in a region where many of those whose names are written large in the history of meteorology have done their work.

DUNN'S 'THE WEATHER.'

'THE Weather' (New York, Dodd, Mead & Co. 1902. 8vo, pp. 356) is designed to 'avoid all mathematics, and scientific and technical terms (!), and present the subject in the simplest and most popular form.' The author is E. B. Dunn, for several years local forecast official of the Weather Bureau in New York City. The book endeavors to cover a large

amount of ground, with the result that most subjects are treated very superficially. There are also a great many inaccuracies. The chapters on weather maps and on weather forecasting are on the whole the best. In no way does 'The Weather' rank with the meteorologies of Hann, Davis, Angot, van Bebber, Mohn, Waldo and others.

NOTES.

THERE has recently been published a 'Catalog der in Norwegen bis Juni 1878 beobachteten Nordlichter, zusammengestellt von Sophus Tromholt' (Christiania, 1902. 4to, pp. 422). This catalogue was prepared for publication by J. Fr. Schroeter, of the University Observatory, Christiania, Tromholt having died on April 17, 1896.

THE volume on Meteorology of the 'International Catalogue of Scientific Literature,' published for the International Council of the Royal Society, is now on sale. It numbers about 200 pages, and costs 15 shillings.

R. DEC. WARD.

GENERAL JAMES T. STRATTON.

AFTER fifty years of professional activity in California, General James T. Stratton, the well-known surveyor, died at his home in Oakland on March 15. General Stratton was born in the state of New York in 1830, and came to California in 1850. After mining for a few years he resumed his professional work in 1853 and made the first official survey of the Alameda Encinal, at that time an uninhabited region. In 1858 he was elected county surveyor of Alameda County and was subsequently identified with the surveys of the large land grants made by the Spanish and Mexican authorities; through the knowledge acquired in this connection, he became a recognized expert on such land grants, their titles and boundary lines. He subdivided more of these, in many cases, immense areas, than any other surveyor in California. He also made the first survey for a railway out of Oakland by the way of Niles and the Livermore Pass to Stockton; these surveys extended to Folsom, Placerville being the objective point. This work was done for an English syndicate; the project was, however, abandoned because of the civil war. Later the rails were laid on these lines by Stanford and his associates, as the Western Pacific Railroad Company, later merged into the Central Pacific Railroad Company.

In 1873 he was appointed United States Surveyor General for California by President Grant, resigning in 1876 on account of ill health. From 1880 to 1883 he was connected with the State survey general's office, and from the latter date was engaged as a land attorney till 1899. To General Stratton belongs the credit of being the first to make an artificial forest west of the Rocky Mountains, he having in 1869 planted some forty-five acres with Eucalpytus trees of the species *E. globulus* and *E. viminalis*. He was a public-spirited citizen and quiet, unassuming gentleman.

ROB'T E. C. STEARNS.

LOS ANGELES,
April 24, 1903.

SCIENTIFIC NOTES AND NEWS.

MR. ANDREW CARNEGIE has offered to give $1,000,000 for a building for the engineering societies. It is to be situated in New York City, and will provide an auditorium, a library and headquarters for five engineering societies, namely, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Society of Electrical Engineers, the American Institute of Mining Engineers and the Engineers' Club.

FINAL contracts have been signed for the purchase from the Schermerhorn estate of the site in New York City for the Rockefeller Institute. The property acquired extends from Sixty-fourth street to a line 50 feet north of Sixty-seventh street from Avenue A to the East River. The price was about $700,000. The work of construction on the main building will begin about August 1.

BY vote of its council the Astronomical and Astrophysical Society of America will hold its next meeting in affiliation with the American Association for the Advancement of Science at St. Louis during convocation week, 1903-1904.

THE Walker Grand Prize, which is bestowed once in five years by the Boston Society of Natural History, has just been awarded to J. A. Allen of the American Museum of Natural History 'for his able and long continued contributions to American ornithology and mammalogy.' The amount of the prize is $500, but in view of the high character of Mr. Allen's investigations, it was voted to increase the amount to one thousand dollars. Among the chief of Mr. Allen's investigations are his 'Birds of Florida,' 'A Monograph of the Pinnepeds,' 'Monographs of North American Rodentia' and 'The Geographical Distribution of North American Mammals.' The prize was last given (1898) to Samuel H. Scudder, of Cambridge, Mass., in recognition of his entomological work.

DR. JOHN H. MUSSER, of Philadelphia, has been elected president of the American Medical Association.

A BRANCH of the American Institute of Electrical Engineers has been organized at Washington, with Dr. Frank A. Wolff, Jr., as chairman.

SIR FREDERICK TREVES, the well-known English surgeon, has been given the LL.D. degree by the University of Aberdeen.

THE Geographical Society of Paris has conferred the La Roquette gold medal on Captain Sverdrup, the Arctic explorer.

ABOUT fifty German students of agriculture are at present in the United States and will remain here about three months investigating agricultural methods.

DR. EDMUND OTIS HOVEY returned on May 8 from a three months' trip to the Caribbean Islands. He was sent out by the American Museum of Natural History to continue and extend the observations on the West Indian volcanoes which he began directly after the great eruptions of a year ago. During the present trip, Dr. Hovey visited all the volcanoes from Saba to St. Vincent, devoting most of his time to Martinique and St. Vincent. Many fine specimens and photographs were obtained for the museum.

PROFESSOR HENRY S. GRAVES, director of the Yale School of Forestry, has gone abroad, and will spend the summer on the continent studying schools and methods of forestry.

DR. F. S. EARLE, assistant curator at the New York Botanical Garden, sailed for Porto Rico on May 9 to make an investigation of the diseases which affect the vegetable products of the island.

PROFESSOR J. C. MERRIAM, of the department of geology, University of California, will go to the southeastern part of Idaho this summer to search for reptilian remains in a portion of the Triassic formation lower than those in which such remains have been found.

PROFESSOR A. A. VEBLEN, of the department of physics at the State University of Iowa, will spend his summer vacation in making a visit to Norway. While absent he will study the history and development of ancient ship building as evidenced by the remains of old vessels preserved in the museums of that country.

THE board of regents of the University of Michigan at their April meeting granted leave of absence for the year 1903–04 to Dr. Herbert S. Jennings, assistant professor of zoology. Dr. Jennings will spend the year at the Zoological Station at Naples, Italy, in prosecuting investigations on the behavior of the lower organisms, continuing researches on which he has been engaged for some years. For the furtherance of this work the Carnegie Institution has made a grant of $1,000, in addition to the sum of $250 granted last fall, together with the use for the year of one of the tables maintained by the institution at the Naples Zoological Station. Dr. Jennings expects to leave for Italy at the close of the summer session in August.

THE large number of fossil fishes collected during the excavations at Boonton and elsewhere in the Triassic area of New Jersey during the last year or two are being studied by Dr. Charles R. Eastman, of the Museum of Comparative Zoology, Cambridge, Mass.

THE first link, Vancouver to Fanning Island, of the transpacific longitude, of which Mr.

Otto Klotz has charge, has been successfully established.

A REUTER telegram from Cape Town states that Dr. Rubin has left for Chinde, with an expedition numbering 280 persons, for the purpose of measuring an arc of meridian into northeastern Rhodesia, from the Zambesi to Lake Tanganyika. The expedition will be away three years, and is expected to yield important data in connection with the determination of the earth's dimensions.

IT is reported from Berlin that Mr. Walker, who is scheduled as the successor of John Eliot as superintendent of the German Indian Meteorological Service, recently spent a week at the aeronautical observatory with a view to establishing experimental stations in India for the observation of monsoon conditions by means of kites and kite balloons. The first station will be in the Himalayas at Simla, seven thousand feet above the level of the sea.

A PORTRAIT of Dr. James H. Richardson, for many years professor of anatomy in the Medical Department of Toronto University, has been presented to the university by his former students.

AT the British National Physical Laboratory, Mr. C. C. Paterson has been appointed to take charge of the electro-technical and photometric work, and Mr. F. J. Selby has been appointed to prepare certain tide tables for Indian ports and to act as librarian.

THE centennial of the birth of Justus Liebig was celebrated on May 12 at the Chemists' Club, New York City. Dr. Ira Remsen, president of the Johns Hopkins University, and Professor William H. Brewer, of Yale University, were expected to make the principal addresses.

MR. ARTHUR E. SWEETLAND, the youngest member of the staff of the Blue Hill Meteorological Observatory, died on May 8. Mr. Sweetland had been connected with the Observatory since 1896, and several of his investigations, notably a study of cloud forms which had long occupied his attention, were published in the *Annals* of the Harvard College Observatory. He also aided the director, Mr. Rotch, to obtain the first meteorological records high above the Atlantic Ocean, as was described in SCIENCE in 1901.

THE daily papers state that Dr. R. N. Hartman, professor of analytical chemistry at the School of Mines at Golden, Colo., was killed by escaping gas in his laboratory on May 8.

WE regret also to record the death of Professor Carl Anton Bjerknes, professor of pure mathematics at the University of Christiania, at the age of seventy-eight years, and of Dr. G. C. Dibbits, formerly professor of chemistry at Utrecht, at the age of sixty-four years.

UNIVERSITY AND EDUCATIONAL NEWS.

THE enlargement of the Silliman Laboratory of the Mount Hermon School is rapidly approaching completion. This enlargement was made possible through a gift of $13,000 from Hon. H. B. Silliman, who erected and equipped the original building in 1892. The laboratory when completed in June will represent the expenditure of nearly $40,000 by Dr. Silliman for scientific purposes. Professor C. E. Dickerson, who is in charge of the laboratory, has directed the work of enlargement.

THE late Walter D. Pitkins has bequeathed $10,000 to Yale University, one half to be used for a scholarship and one half for a prize in mathematics.

THE Harvard Club of Chicago has given $5,000 to found a scholarship in memory of Dunlop Smith.

MR. FRANCIS L. STETSON, of New York, has given $25,000 to Williams College. Mr. Robert C. Billings has given the same sum to Wellesley College.

DR. GEORGE M. TUTTLE, professor of gynecology; Dr. George L. Peabody, professor of materia medica and therapeutics, and Dr. Robert F. Weir, professor of surgery, have resigned their chairs in the College of Physicians and Surgeons, Columbia University. Dr. Weir was appointed professor of clinical surgery, and Drs. J. A. Blake and G. E. Brewer were made lecturers in surgery. Dr. Christian A. Herter was elected professor of pharmacology and therapeutics. Dr. Edward B. Cragin succeeds Dr. Tuttle in the department of gynecology.

AMONG the promotions and new appointments at Columbia University are Dr. C. C. Trowbridge and Dr. F. L. Tufts to be instructors in Physics; Dr. B. Davis, tutor in physics; Dr. A. P. Wells, instructor in mechanics; Dr. R. S. Woodworth, instructor in psychology, and Dr. W. P. Montague, lecturer in philosophy.

DR. G. H. HOWE, now assistant professor of physics at Dartmouth, has been elected to the Appleton professorship of physics, in succession to Professor E. F. Nichols, who has been called to Columbia University.

AT a recent meeting of the board of trustees of the New Mexico School of Mines six additional chairs in the faculty were established. These were mining, physics and electrical engineering, mechanical engineering, mineralogy and petrography, metallurgy and languages. Several special lectureships were also provided. Carl E. Magnusson, B.E.E., Ph.D., from Wisconsin University, has been appointed to the chair of physics and electrical engineering; Charles T. Lincoln, B.S., of the Massachusetts Institute of Technology, has been appointed acting professor of chemistry, and Francis C. Lincoln, B.S., M.E., late of the San Barnardo Mining and Milling Co., has been placed in charge of the metallurgical department. President Keyes announces that hereafter regular summer work will be carried on at the institution. This work will continue through seventeen weeks and will count as a half year's credit. Field work in geology, surveying and mine examinations, and special investigation will occupy the time of certain classes. Practical metallurgy in its various phases will also be carried on.

THE University of Montana will be well represented this summer both in field and class work. The University Summer School will open June 15, and continue for six weeks. Eleven departments will offer work, and the new Woman's Hall will be completed and opened for this session. The Biological Station work, at Flathead Lake, under the directorship of Professor M. J. Elrod, with a corps of instructors, will give several field and laboratory courses both in botany and zoology. The station will open the middle of July and continue for five weeks. The department of geology will conduct an expedition in the southeastern part of the state. This expedition will be composed of several students and an official photographer, and be in charge of Professor J. P. Rowe. The party will leave the university about the middle of June and remain in the field from six to eight weeks.

DIRECTOR R. H. THURSTON, of Sibley College, Cornell University, has accepted an invitation from the trustees and faculty of the Iowa State College at Ames, Iowa, to deliver the address at the dedication of the new engineering hall on May 21. The new building was built at a cost of $220,000.

THE Rev. Charles S. Murkland, who for the past ten years has been president of the Agricultural College, Durham, N. H., has been forced to resign. According to the *Manchester Union*, the governor of the state, Mr. Bachelder, may be made president. This newspaper indicates that there are political intrigues in connection with the presidency.

A SCHOOL of applied science has been created by the board of regents of the University of Iowa, and Professor L. G. Weld has been appointed director.

MR. WILLIAM KENT, of New York City, has been elected dean of the L. C. Smith College of Applied Science of Syracuse University.

PROFESSOR ROBERT SAMPLE MILLER, associate professor of mechanical engineering at Purdue University, has been elected to a similar position in the newly organized department of engineering at Colorado College. At this institution Dr. Florian Cajori, professor of mathematics, has been elected dean of the school of engineering.

DR. NORMAN M. HARRIS, associate professor of bacteriology at the Johns Hopkins Medical School, has accepted a call to the University of Chicago.

MR. C. A. ASHFORD, who has had charge of the teaching of science at Harrow since 1894, has been appointed headmaster at the Royal Naval College, Osborne.